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ELECTRICAL REVIEW.

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THE

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FLUCTUATIONS.

EVERY year sees its fluctuations in prices, very much as every season has its variations in sunshine or rainfall. The elimination of fluctuations has been peculiarly the province of the engineer, yet the fact remains that, in regard to the commodities used in his own manufacturing operations, he is himself severely affected by the rise and fall of prices. Water storage in connection with irrigation schemes or power schemes has been applied to neutralise the inequalities of Nature. Locks are employed in the shallow portion of non-tidal rivers so that navigation may be carried on during dry seasons. The mechanical engineer has used the fly-wheel and the governor in order to regulate the working conditions on the engine itself; as a result small fluctuations due to irregularity in the turning moment during each cycle are smoothed out, while larger fluctuations in the load itself are met by one or another type of governor. Commerce has certainly its fly-wheel in the shape of the visible supply of the commodity under consideration, and the slowing of the fly-wheel due to a restriction of supply brings a very brutal type of governor into play. Prices rise abnormally, and oscillations follow very much in the same way that a tachometer needle oscillates when a governor is hunting, or lights flicker when alternators are unskilfully paralleled. During the past six months prices have been wholly abnormal in regard to both copper and tin. Concerning copper, while there are instances on record of rises surpassing the present high value, there has never before been a time when £80 per ton could be regarded as endemic rather than epidemic. As regards tin, although there has been a decline from the high-water mark of summer prices, a price in the neighbourhood of £180 cannot but be regarded as abnormal. Finally we have had the spectre of steel attaining the rarity of copper, paraded as a possibility if the consumption of iron ore continues to increase at its present rate and no fresh ore deposits are discovered.

The fact therefore remains, that although the civil engineer has, in certain notable directions, reduced the fruits of the years to the better reckoning of a more equable rate of production, and that while the mechanical engineer endeavours to reduce the fluctuations in the turning moment of his engines, the engineering manufacturer is practically without remedy for the wide range of prices dominated by the laws of supply and demand. The complexity of the problem of commercial fluctuations is well illustrated by Mr. Herbert Spencer's plea for the need of the study of sociology. Taking as a simple phenomenon the price of cotton, the many factors determining its price are enumerated. We will quote Mr. Spencer's hypothetical case :—"A manufacturer of calicoes has to decide whether he will increase his stock of raw material at its current price. Before doing this, he must ascertain, as well as he can, the following data: Whether the stocks of calico in the hands of manufacturers and wholesalers at home are

large or small; whether by recent prices retailers have been led to lay in stocks or not; whether the colonial and foreign markets are glutted or otherwise; and what is now, and is likely to be, the production of calico by foreign manufacturers. Having formed some idea of the probable demand for calico, he has to ask what other manufacturers have done, and are doing, as buyers of cotton—whether they have been waiting for the price to fall, or have been buying in anticipation of a rise. From cotton-brokers' circulars he has to judge what is the state of speculation at Liverpool—whether the stocks there are large or small, and whether many or few cargoes are on their way. The stocks and prices at New Orleans, and at other cotton ports throughout the world, have also to be taken note of; and then there come questions respecting forthcoming crops in the Southern States, in India, in Egypt and elsewhere. Here are sufficiently numerous factors, but these are by no means all. The consumption of calico, and therefore the consumption of cotton, and therefore the price of cotton, depends in part on the supplies and prices of other textile fabrics. If, as happened during the American Civil War, calico rises in price because its raw material becomes scarce, linen comes into more general use, and so a further rise in price is checked. Woollen fabrics also may to some extent compete. And besides the competition caused by relative prices, there is the competition caused by fashion, which may or may not presently change. Surely the factors are now all enumerated? By no means. There is the estimation of mercantile opinion. The views of buyers and sellers respecting future prices, never more than approximations to the truth, often diverge from it widely. Waves of opinion, now in excess, now in defect of the fact, rise and fall daily, and larger ones weekly and monthly, tending, every now and then, to run into mania or panic; for it is among men of business as among other men, that they stand hesitating until some one sets the example, and then rush all one way, like a flock of sheep after a leader. These characteristics in human nature, leading to these perturbations, the far-seeing buyer takes into account, judging how far existing influences have made deviate from the truth, and how far impending influences are likely to do it. Nor has he got to the end of the matter even when he has considered all these things. He has still to ask what are the general mercantile conditions of the country, and what the immediate future of the money market will be; since the course of speculation in every commodity must be affected by the rate of discount. See, then, the enormous complication of causes which determine so simple a thing as the rise or fall of a farthing per pound in cotton some months hence!" Our readers may easily substitute iron or copper or any other commodity, such as cement or tin, *mutatis mutandis*, for cotton in the preceding quotation. Written as it was some 33 years ago, the years have only made for further complexity. Markets and competitors have multiplied. Transport facilities are more numerous, while means of intercommunication bring into constant touch remote markets.

The improvements of engineering science have, in fact, failed, and must continue to fail, to eliminate fluctuations in the price of commodities. Supply and demand cannot balance until the output of food-stuffs throughout the globe is constant, until death-rate and birth-rate balance, until appetite and custom remain constant. Engineering improvements may continue to obliterate the many local oscillations in price; but while the small local excess is smoothed out to the point of disappearance, the large local excess, spread over many markets, will affect all to a less degree. Fluctuation always has been, and always will be. Engineering manufacturing must remain subject to it, although the degree of subjection will be a varying quality. We may restrain fluctuation with success in the problems of engineering science, but we can only anticipate it with the skill often called luck in the problems of engineering commerce.

The Cultivation of Fuel.

As to the solution of the fuel famine which is in the background of innumerable social and economic theories, we have had suggestions innumerable. The winds and tides have afforded many texts for discourses. Writing on the subject of "Alcohol and the Future of the Power Problem" in *Cassier's Magazine*, Mr. Elihu Thomson propounds another suggestion, for which there is much to be said when coal has reached fancy prices. Dealing with our reckless fuel wastes, it is pointed out that even immediate repentance and reformation will only defer the date of ultimate exhaustion. Ethyl alcohol is acclaimed as one solution, as "the production on a large scale is very simple, and the raw materials already exist in considerable variety. All saccharine or starchy growths are available. Saccharine wastes are now largely used in Cuba for alcohol production. About 3 gallons of crude molasses costing 3 cents per gallon will be required to produce a gallon of 90 per cent. alcohol." Estimating the cost of production at 3 or 4 cents, such alcohol would only cost about 12 cents per gallon. The author proceeds to point to its value as a substitute for the mineral oil derivations in specially designed internal combustion engines. The particular feature of alcohol as a fuel is outlined in the following words:—

> A very important fact distinguishing alcohol production by agriculture from the production and shipment out of the land of food products, meat, &c., or even wood, is that in the former the land is not impoverished, as the mineral and nitrogenous matters can be returned to it, while in the food and wood carried away the richness of the land is passing away, too. Alcohol contains only carbon, hydrogen, and oxygen, all of which come from the air itself. The transformation is begun in the carbonic acid and water of the air reaching the growing plant under the influence of sunshine, and completed in the fermenting vat and the still under human direction. Vigorous plant growth is a cooling process; solar energy is rendered latent or potential. It would even be possible to calculate from the fuel value of any growth or crop the proportion of the solar energy so stored up. Fermentation renders the energy stored more available, and distillation finally yields a concentrated product.

There is much to be said for such a view. Of course the era of absolute coal exhaustion is a distant one. It will dawn slowly, and when we are compelled to think more seriously than we do at present, it will be well to meditate on the relative permanence of an agricultural as contrasted with the ephemeral evanescence of a mining industry.

Motor-'Buses in Trouble.

It has always been one of the boasts of motoring enthusiasts that the brakes with which their cars are equipped are so powerful that they can stop "dead"—a phrase which, in the absence of irresistible force or an immovable obstruction, must be construed as meaning in a very short distance. It was with surprise, therefore, that we read the report of a case tried before a London magistrate last Friday, in which a motor-'bus driver was charged with reckless driving, and the defence set up was that *it was dangerous to put on the brakes quickly*. The magistrate, Mr. Denman, drew especial attention to this contradiction, remarking that it was important that the fact should be publicly known. A similar defence was put forward in another case also. The road was slippery, but that is quite a normal condition on many roads, and we object to being run down simply because the road is not in a particular state. The public safety must be preserved under *all* conditions of road surface.

On Saturday last a motor-'bus ran into a horsed tramcar in Whitechapel, and another knocked down a lamp-post and two guard posts in Whitehall; similar accidents are constantly being reported, and it would seem that the petrol motor-'bus, with its blue haze of oil vapour, its noise and vibration, is not merely noxious to the senses, but is also a danger to life and limb, and will in no long time be voted an unmitigated nuisance.

Speaking of brakes reminds us of the accident on Handcross Hill, due to the failure of the brakes, and it is interesting to note that an "Auto-Mixte" motor-'bus went down the same hill without mechanical brakes at all, depending entirely upon the regenerative electric control. This is a valuable feature of the electric vehicle, and if only the running costs can be brought down to a reasonable figure, we may yet see the electric 'bus, silent, odourless, and under perfect control, gliding about the streets, when the petrol 'bus has sunk into oblivion.

THE VOLTAGE REGULATION OF THE CONTINUOUS-CURRENT DYNAMO.

By H. M. HOBART.

Many methods of estimating the voltage regulation of alternating-current generators have been published, but I am not aware that any good method has yet been published permitting of quick approximate estimations of the regulation of continuous-current dynamos. The chief consideration relates to the influence of the brush position as

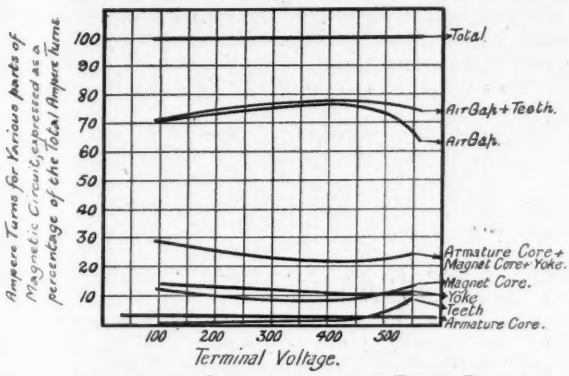


Fig. 1.—Analysis of Saturation Ampere-Turns Required for a 550-kw. Generator.

affecting the magnitude of the armature interference. In 1902[1] I published some articles in the Electrical Review entitled "Armature Interference and Brush Position." Experiments made on the lines of some of the suggestions contained in these articles have been made on various occasions, but generally under conditions precluding the publication of the data obtained. Having recently had occasion to revert to the subject, it became evident that the accumulation of data representing the various attempts to evolve a satisfactory method of predetermining the regulation of continuous-current dynamos had finally paved the way to the end in view.

I have applied the method, which I propose in this article to describe, to a variety of designs, and with invariably satisfactory results, and I propose on the present occasion to describe the method, chiefly by reference to the 550-kw. continuous-current dynamo, which served as example in my 1902 Electrical Review article, to which I have already alluded.

It is customary and convenient to express the total armature interference in terms of the armature ampere-turns per pole, and to regard this interference as consisting of two components, the demagnetising and the distorting ampere-turns. With the brushes in the mechanical neutral point, the demagnetising ampere-turns are equal to zero, and with the brushes displaced through half the polar pitch (*i.e.*, to a position opposite the middle of the pole face), the demagnetising influence reaches a maximum. In the former position, the distorting tendency is at a maximum, and in the latter position it is equal to zero.

The distorting effect is generally far less in magnitude, chiefly owing to the high magnetic reluctance across which it acts. Like the demagnetising effect, it varies in magnitude with the brush position.

I do not wish to claim any high degree of exactness for this method, but would only say that I find it a most useful guide in the predetermination of compound windings, and since it is approximately correct, it affords a means of studying the occurrences in a continuous-current dynamo without entailing an impracticable expenditure of time.

[1] Electrical Review, Vol. 50, pp. 329-331, February 28th; pp. 450-451, March 14th; and pp. 455-457, March 21st, 1902.

The Influence of the Demagnetising Ampere-Turns.—The direct magnetising or demagnetising influence of the armature is readily determined. With the brushes at the geometrical neutral point, the armature ampere-turns are neither magnetising nor demagnetising directly, and they affect the impressed field only as the result of cross magnetisation, or so-called "distortion." With a forward brush lead, the armature ampere-turns of a dynamo demagnetise. With a backward brush lead, they magnetise. Let the number of commutator segments per pole be denoted by A. Let the number of segments forward or backward lead of the brushes be denoted by B. Let the rated full-load current of the dynamo be denoted by C. Let the number of conducting paths through the armature from positive to negative brushes be denoted by D. Let the number of armature-turns per segment be denoted by E. Then the total armature strength at rated full load, expressed in armature ampere-turns per pole-piece

$$= \frac{A\,C\,E}{D}.$$

For a brush lead of B segments, the direct demagnetising armature ampere-turns per pole at rated full-load current

$$= \frac{2\,B}{A} \times \frac{A\,C\,E}{D}$$

$$= \frac{2\,B\,C\,E}{D}.$$

The influence of these demagnetising ampere-turns may be offset by a corresponding number of ampere-turns on the field spool.

The Influence of the Distorting Ampere-Turns.—It is customary to consider that distortion may be limited by employing a "stiff field," by which is generally meant that a considerable magneto-motive force shall be employed to overcome the magnetic reluctance of the air-gap and teeth, which are components both of the circuit traversed by the impressed magnetic flux and by the distorting component of the magnetic flux due to the armature magneto-motive force. Hence in methods for estimating the field excitation necessary to overcome the distorting ampere-turns, it is natural to employ a term proportional to the "saturation ampere-turns for gap and teeth."

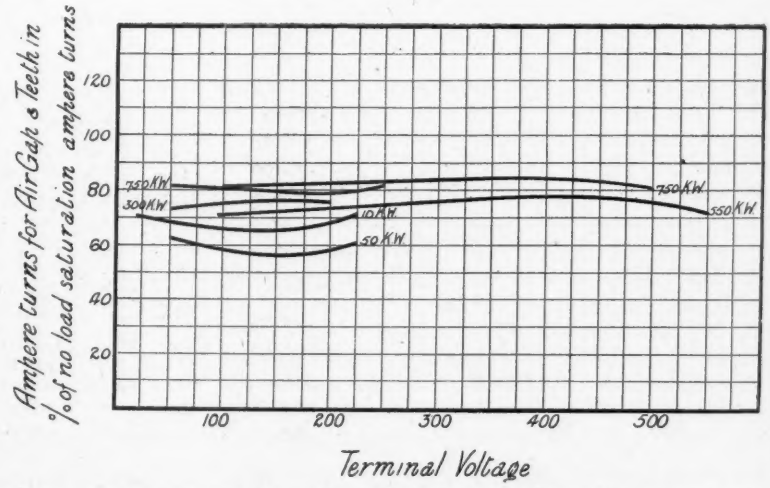


Fig. 2.—Curves showing for Various Machines the Percentage which the Ampere-Turns for Air-Gap and Teeth Constitute of the Total Saturation Ampere-Turns.

It so happens, however, that for all points of the saturation curve of a normally designed continuous-current generator, the "saturation ampere-turns for overcoming the magnetic reluctance of the gap and teeth" constitute a fairly constant percentage of the total saturation ampere-turns. Fig. 1 demonstrates that this is the case for a 10-pole, 550-kw., 90-r.p.m., 550-volt generator analysed for this purpose. In order, however, to ascertain whether or not this is generally the case, a similar analysis was made for five other machines chosen at random. The results are compiled in Table I (p. 286) and are plotted in fig. 2, and it is evident that for all these

D

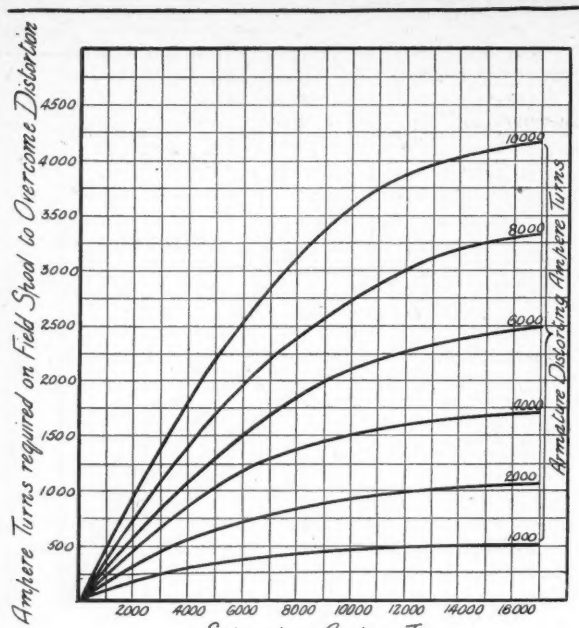


FIG. 3.—CURVES FOR ESTIMATING THE FIELD EXCITATION REQUIRED FOR OVERCOMING ARMATURE DISTORTION.

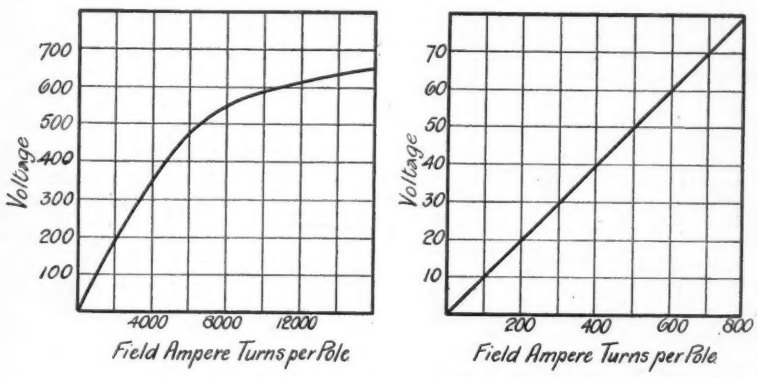


FIG. 4.—SATURATION CURVES FOR 10-POLE, 550-KW., 550-VOLT, 90-R.P.M. RAILWAY GENERATOR.

In estimating the ampere-turns required to overcome armature distortion, it is evidently much more convenient to introduce a term expressing the total saturation ampere-turns per field spool, which may be obtained directly from the no-load saturation curve (whether predetermined or observed), than to go to the additional labour of decomposing the saturation curve into its components or of estimating separately the saturation ampere-turns for gap and teeth. With these considerations in mind, the curves in fig. 3 have been built up from experimental data, and will be found very convenient for the purpose of estimating the additional excitation per field spool, requiring to be provided in order to overcome the influence of the distorting component of the armature interference. The total distortion ampere-turns per pole at rated full-load current C and for brush position B—

$$= \frac{A\,C\,E}{D} - \frac{2\,B\,C\,E}{D}$$

$$= (A - 2\,B)\,\frac{C\,E}{D}.$$

We are now in a position to apply these principles to the case of the 10-pole 550-KW. design described in the ELECTRICAL REVIEW article.*

At the left-hand side in fig. 4, a saturation curve is plotted for values up to 650 volts, and an additional curve for the saturation ampere-turns required to overcome armature and brush C R drop with brushes short-circuited is shown at the right-hand side of the figure.

In fig. 5 are given excitation regulation curves for various amperes output and terminal voltages. As ordinates are plotted the required excitations in ampere-turns per field spool, and as abscissæ, the corresponding brush positions.

An interesting feature of this diagram is that the excitation curves for different loads, at the lower voltages, meet at a certain brush position backward from the neutral point.

This point corresponds to the brush position necessary for the armature to be self-regulating for constant voltage in virtue of armature interference at all loads at the particular voltage for which the curves are plotted.

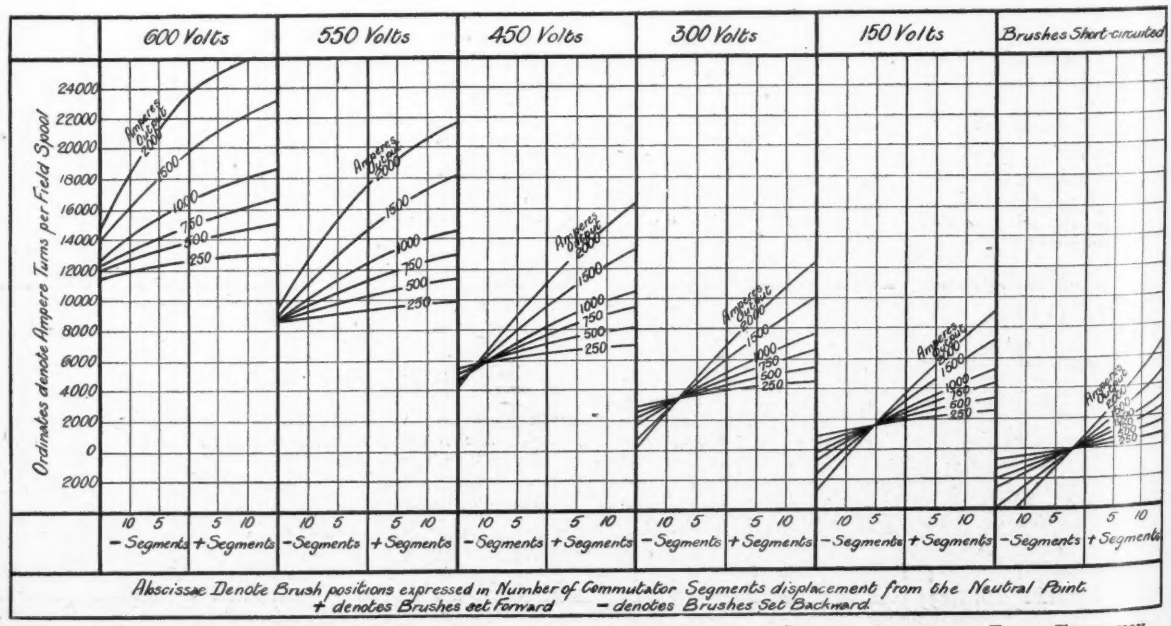


FIG. 5.—TRAMWAY GENERATOR, 10 POLES, 550 KW., 550 VOLTS, 90 R.P.M. CHART OF CURVES SHOWING THE FIELD EXCITATION REQUIRED AT VARIOUS BRUSH POSITIONS, AND FOR VARIOUS VOLTS AND AMPERES OUTPUT.

designs the values for the "ampere-turns for gap and teeth" expressed as a percentage of the total saturation ampere-turns per field spool are fairly constant quantities.

* ELECTRICAL REVIEW, Vol. 50, pp. 329-331, February 28th; pp. 450-451, March 14th; and pp. 455-457, March 21st, 1902.

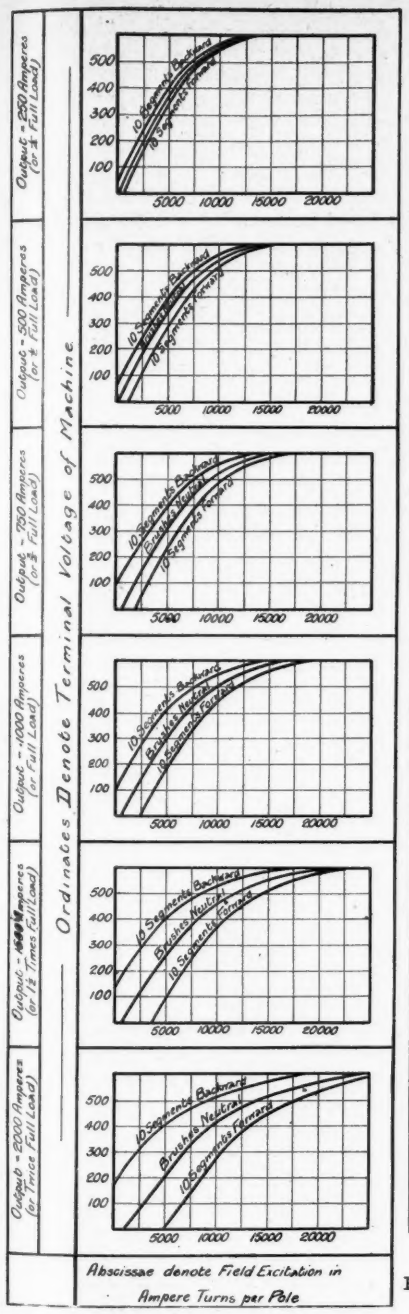

Output = 2250 Amperes (or ⅓ Full Load)
Output = 500 Amperes (or ⅔ Full Load)
Output = 750 Amperes (or ¾ Full Load)
Output = 1000 Amperes (or Full Load)
Output = 1500 Amperes (or 1½ Times Full Load)
Output = 2000 Amperes (or Twice Full Load)
Ordinates Denote Terminal Voltage of Machine
10 Segments Backward
10 Segments Forward
Brushes Neutral
Abscissae denote Field Excitation in Ampere Turns per Pole

FIG. 6.—SATURATION CURVES FOR A 550-KW., 550-VOLT, 90-R.P.M. TRAMWAY GENERATOR, AT DIFFERENT LOADS AND BRUSH POSITIONS.

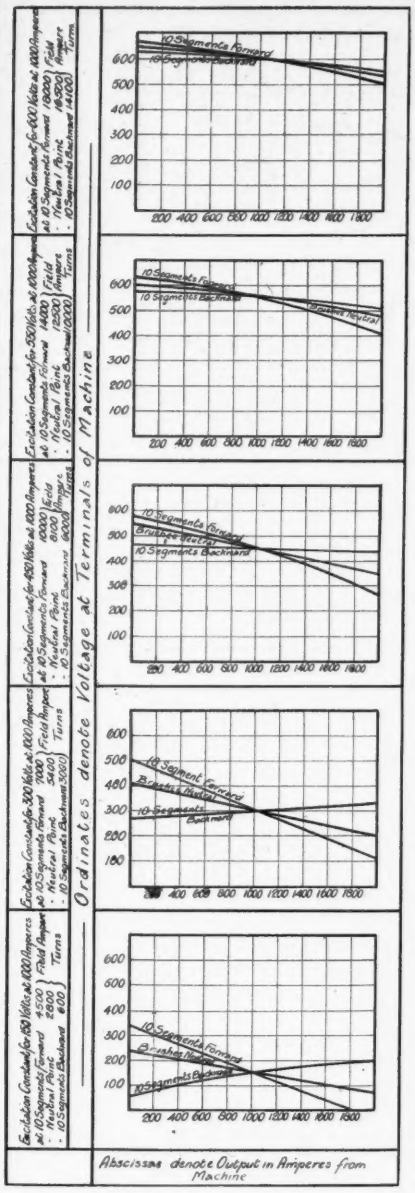

Ordinates denote Voltage at Terminals of Machine
10 Segments Forward
10 Segments Backward
Brushes Neutral
Abscissae denote Output in Amperes from Machine

FIG. 7.—550-KW. GENERATOR. CURVES OF INHERENT REGULATION WITH CONSTANT FIELD EXCITATION, FOR VARIOUS VOLTAGES AT FULL-LOAD CURRENT.

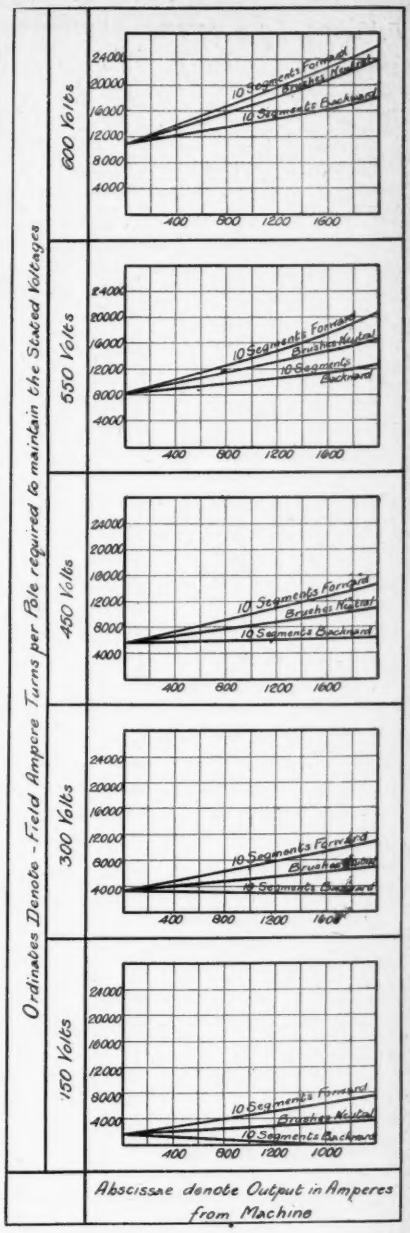


FIG. 8. — 550-KW. GENERATOR. EXCITATION REGULATION CURVES, SHOWING EXCITATION REQUIRED TO MAINTAIN GIVEN VOLTAGES AT VARIOUS AMPERES OUTPUT.

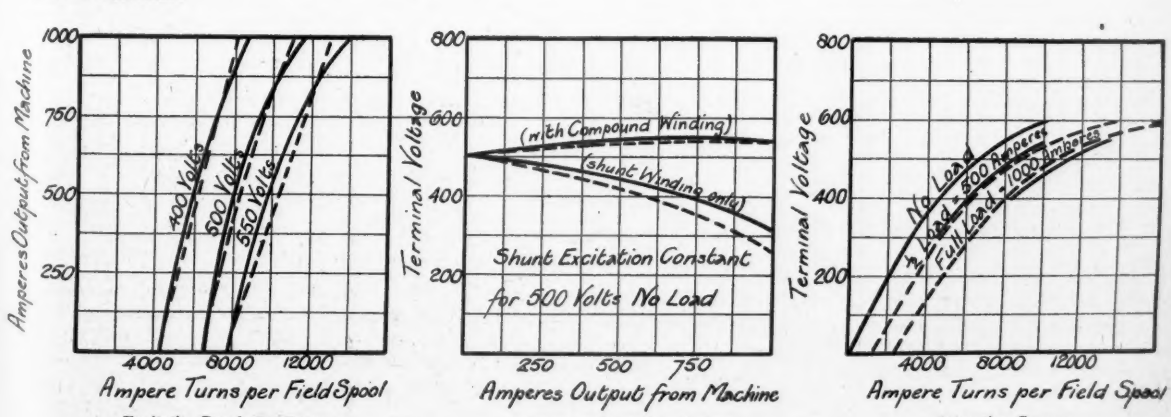


FIG. 9.—550-KW. TRAMWAY GENERATOR. Full lines show actual results obtained on test (from ELECTRICAL REVIEW, March 21st, 1902, p. 456). Broken lines show predetermined curves by method described in this article (8 segments brush lead in all cases).

It will be noticed for the higher voltage curves that the crossing of the various load lines does not occur at a single point, but that the curves for higher loads cross further back than the curves for lighter loads. This is due to working

Table I.—Field Ampere-Turns.

kw.	Voltage.	Core.	Teeth.	Air gap.	Magnet core.	Yoke.	Total ampere turns (t).	Air gap and teeth (s).	s in per cent. of (t).
10	50	8	5	237	43	58	315	242	69·0
10	100	20	14	472	67	160	733	486	66·0
10	150	32	138	710	95	314	1,289	848	66·0
10	220	68	1,000	950	210	515	2,743	1,950	71·0
50	50	30	8	306	60	102	507	315	62·0
50	100	45	15	612	105	306	1,083	627	58·0
50	150	60	42	918	135	612	1,767	960	56·0
50	200	75	510	1,224	210	950	2,969	1,734	58·0
50	225	105	1,410	1.460	405	1,260	4,640	2,870	61·8
300	50	38	9	1,120	170	200	1,537	1,129	73·5
300	100	38	21	2,240	272	400	2,971	2,261	76·0
300	150	76	101	3,360	340	680	4,557	3,461	76·0
300	205	142	2,500	4,770	770	1,360	9,542	7,270	76·5
550	100	35	5	940	160	180	1,320	945	71·5
550	200	63	15	1,870	276	330	2,554	1,885	74·0
550	300	88	25	2,800	345	420	3,678	2,825	77·0
550	400	105	50	3,760	415	510	4,840	3,810	79·0
550	450	122	90	4,200	505	570	5,487	4,290	78·5
550	500	140	250	4,700	690	660	6,440	4.950	77·0
550	550	175	750	5,170	1,060	900	8,055	5.920	73 5
750	50	17	9	1,084	120	120	1,350	1,093	81·0
750	100	37	37	2,170	210	270	2,703	2,186	81·0
750	150	41	41	3,250	270	480	4,086	3,295	81·0
750	200	66	66	4,320	450	780	5,976	4,680	78·5
750	230	74	2,000	5,100	600	1,100	8,847	7,100	80·2
750	100	25	15	1,190	160	87	1,477	1,205	81·7
750	200	63	20	2,390	280	174	2,927	2,410	82·4
750	300	75	70	3.580	360	290	4,375	3,650	83·5
750	400	100	400	4,780	480	425	6,195	5,180	83·7
750	500	175	2,000	6,100	1,100	580	10,555	8,100	80 5

high up on the saturation curve, where the few extra volts necessary to offset the armature resistance drop at heavier loads, require a much greater increase in field ampere-turns.

In fig. 6, p. 285, load saturation curves are plotted for this machine with the brushes in the neutral position, and 10 segments in advance and behind that position respectively.

A striking contrast is apparent between the quarter load and the double full load curves; the excitation required for 2,000 amperes load and 10 segments brush lead, being twice the excitation required for 250-amperes load at a similar brush position.

In fig. 7 are given the corresponding curves of inherent regulation with excitation constant at the value required to generate the stated voltages at full load of 1,000 amperes.

In fig. 8 are plotted curves showing the excitation required to maintain different voltages at different loads.

Table II.—550-kw. Tramway Generator.

Number of poles	10
Rated voltage	550
Speed in r.p.m.	90
Amperes output at rated load	1,000
Number of face conductors	1,800
Number of commutator segments	900
Number of armature slots	300
Size of slots, mm.	51 × 13·3
Length of pole arc in cm.	60
Armature core diameter (external), cm.	244
„ „ (internal), cm.	180
Gross length of core, cm.	52
Effective length of core, cm.	38
Magnet core diameter, cm.	47
„ „ length, cm.	46
Radial depth of air-gap, mm.	9·5
Yoke external diameter, cm.	400
Yoke internal diameter, cm.	350
Yoke cross-section (magnetic), sq. cm.	1,930
Material of cores and yoke	Cast steel

In fig. 9 are given sets of curves showing the agreement between curves predetermined by this method and curves plotted from test results, the latter having been reproduced from the 1902 Electrical Review article. A brief summary of the necessary data of this 550-kw. dynamo is given in Table II.

Much more complete data of this design will be found on pp. 205-214 of "Electric Machine Design," but the writer wishes to take advantage of this occasion to point out that the method described in the present article should replace that set forth on pp. 161-164 of the above-mentioned treatise, since the latter method, while put forward with good intentions, has since been seen to involve erroneous deductions, and the curves of fig. 160 on p. 164 are radically unsound.

CALCULATION OF STARTING APPARATUS FOR SINGLE-PHASE INDUCTION MOTORS.

In the following pages will be suggested a simple graphical method for the predetermination of the starting torque, and for a rational calculation of the starting phase and starting apparatus in the single-phase induction motor without commutator.

The starting of this class of machine, when not self-starting, can be effected, as is well known, by means of resistances, choking coils, or condensers outside the motor.

In this article will be considered the systems of external appliances involving the use of resistances and impedance coils. The main and starting phases are supposed to be wound at 90 electrical degrees in space and in different numbers of similarly shaped slots.

Let us consider the polyphase wound rotor when standing still under the action of two 90°-displaced fields having a certain phase relation.

It can be easily seen that this polyphase rotor in all respects can be replaced by a two-phase wound rotor, each phase of which has the same winding distribution as one of the phases in the rotor, half the total number of turns, and the same coil axis as one of the stator phases. In other words, these two rotor phases can be considered as the secondaries of two independent transformers, the primaries of which are the two stator phases.

We can apply the Heyland diagram to each of these two transformers if we know the leakage factors σ_1, σ_2.* By neglecting, for simplicity's sake, the iron and primary copper losses, we can trace the diagram of fig. 1, where we have $\frac{AB}{BC} = \sigma_1$, A N = V the applied voltage, A B = i_0, the magnetising current, or in another scale the resulting flux cutting the primary conductors, A B^1 is the resulting flux in the secondary, A C the short circuit current, A F the primary current corresponding to a certain resistance in the secondary, B F the current in the secondary given by

$$I_0^1 = \nu_1 \frac{k_1}{k_2} \frac{n_1}{\left(\frac{n_0}{2}\right)} \frac{i_1}{A\,F} \text{ B F.} \qquad (1)$$

Where ν_1 is the primary leakage coefficient, n_1, n_0 the conductors in the phase considered, and in the rotor, k_1, k_2 the form factors.

It will be of some use to note that if we trace the perpendicular F Z to A C, and we take the segment Z F as representing the resistance of the rotor necessary to have the primary current A F, it will be easy to find the primary and secondary currents corresponding to a certain resistance Z M by tracing the straight line B M, which cuts the circle in the point F_1. The segments A F_1, B F_1 represent the primary and secondary currents of the transformer, when the resistance of the secondary is Z M.

If the leakage factor for the other phase is σ_2, we can trace another similar diagram, and if we know the angle of phase difference between the voltages applied to the two phases, we are able to find all the phase relations of all the vectors representing the magnetic and electric elements of the two transformers.

Now we have to consider the electro-magnetic actions between the currents of each secondary, and the secondary flux of the other transformer. By applying the general expression of the torque after little transformations, we arrive at $C = \cdot 96 \frac{r_0}{N} I_0^1 . I_0^{11} \sin \beta$ where C is the torque in kg. metres; r_0 the total resistance of the rotor; I_0^1, I_0^{11} the

* If we call ν_1, ν_2 the leakage coefficients or ratio between the flux produced by one member and the flux cut by the other, we have $\sigma = \nu_1 \nu_2 - 1$.

secondary currents, and β the angle of phase difference between them or between the primary currents, as can be proved to be the same. N in revs. per minute is the speed of the machine.

From that formula we can easily arrive at the following simple expression :—

$$C = \frac{1{\cdot}92}{N} \sqrt{P_1 P_2} \sin \beta. \qquad (2)$$

Where P_1, P_2 are in watts the powers absorbed by the two phases.*

As a check, we see that in the case of a two-phase motor being $P_1 = P_2 = \frac{P}{2}$, where P is the power in watts absorbed at starting, and $\beta = 90°$, we have $C = \frac{{\cdot}96}{N} P$, which is the well-known formula for the starting torque in a polyphase induction motor.

In an ordinary motor, such as the one we have supposed, the leakages of the two phases are not equal, the two windings being distributed in different numbers of slots, but if we take them as equal we shall not commit any considerable error. It will be easily seen that in this case if the same voltage is applied to both phases $\beta = 0$, and in consequence $C = 0$. To obtain this angle β of phase difference by using resistance or self-induction, we distinguish the case of motors with slip-ring rotors, in the windings of which resistances can be inserted, from the other case of short-circuited rotors. In the first case only the use of self-induction is advisable, while in the second case only resistance should be used.

The use of self-induction and resistance at the same time in the primary windings, while complicating the starting apparatus, is generally useless, and sometimes detrimental for obtaining a good starting torque with a given absorbed current. This can be easily proved with the help of the diagrams which we are going to establish.

Motors with Slip Ring Rotors.—A choking coil is put in series with the auxiliary phase and the main is fed directly by the available voltage ; in the rotor circuits are inserted resistances.

If we call n_1, n_2 the numbers of conductors in the main and auxiliary phase, and k_1, k_2 the form factors respectively, the ratio of the impedances of these phases is

$$q = \left(\frac{k_1 n_1}{k_2 n_2}\right)^2 \dagger$$

If we neglect the copper and iron losses of the choking coil, the voltage V_3 on its terminals will be at 90° to the current I_2 passing through it, and the auxiliary phase. This current makes a certain angle φ with the voltage V_2 on the auxiliary phase terminals, the angle φ being the same as the angle between the available voltage V_1 and the current I_1 in the main phase. We see then that the vectors representing the voltages V_2, V_3 make the angle $90 + \varphi$, while their vectorial sum is the vector V.

With these few remarks the following construction can be easily understood. (Fig. 1.)

Take F R $= q$. A F, trace a circle F R having its centre on the perpendicular F Z, and passing through the points F R. This arc of circle F L R is the locus of all the currents (F L) passing through the auxiliary phase, and the total currents (A L) absorbed from the supply main, for different values of the choking coil impedance.

The angle of phase difference β is the angle L F R. The ratio $\frac{F L}{L R}$ represents the ratio of the auxiliary phase and choking coil impedances. The voltages V_2 and V_3 are given by $V_2 = \frac{F L}{F R} V$, $V_3 = \frac{L R}{F R} V$.

When the choking coil is cut out, evidently F R is the current going through the auxiliary phase, A R the total absorbed current, $\beta = 0$, $C = 0$.

By applying the general formula (2), we can arrive at

$$C = \frac{1{\cdot}92}{N\sqrt{q}} \cdot S \cdot T T^1. \qquad (3)$$

Where S is the scale of powers in the graphic, and T T^1 is a segment given by the diagram.

We see at once that the best starting torque for a given resistance in the rotor (φ constant) is given when F L = L R, that is, when the choking coil and auxiliary phase impedances are equal.

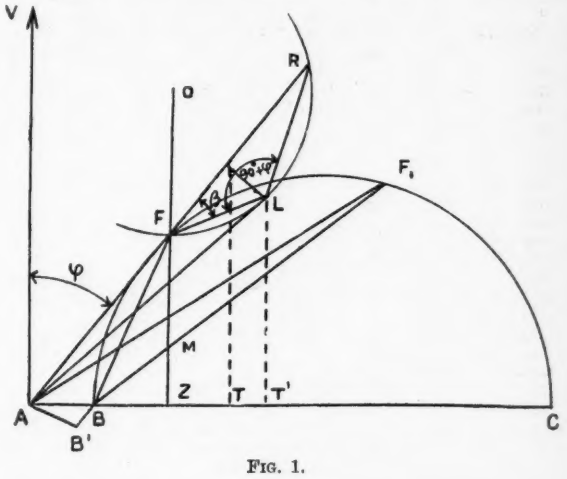


Fig. 1.

We see also that for a certain resistance of the rotor the maximum ratio between starting torque and current is given when A L is tangent to the circle F L R, or when the total absorbed current is given by $I_1 \sqrt{1 + q}$. It is interesting to note that the maximum possible starting torque is given by $C = \frac{1{\cdot}92}{N} \frac{V}{8\sigma(1 + 2\sigma)} \sqrt{i_1 i_2}$; i_1, i_2 being the magnetising currents of the two phases. This maximum starting torque is obtained when the current in the main phase is equal to the mean value of magnetising and short-circuit currents, and the choking coil and auxiliary phase impedances are equal.

In practice the problem is to proportion the starting phase, the choking-coil impedance and the resistance in the rotor in such a way as to get the maximum torque with a given current absorbed from the mains.

To illustrate the method, let us take a practical case of a 110-H.P. induction motor made by the G.E.C. at their works at Witton. The machine runs at 740 r.p.m., 400 volts, 50 cycles. We have $n_1 = 160$, $n_2 = 288$, the main and the auxiliary phases being respectively distributed on two-thirds and one-third of the pole pitch.

We have $k_1 = 1{\cdot}85$, $k_2 = 2{\cdot}12$, the form factor for the three-phase wound rotor is $k_0 = 2{\cdot}12$.

We have also $\sigma = {\cdot}045$, $i_1 = 36$ amps. and a full-load torque of 106 kg. metres.

The current at starting must be 270 amps., which is the full-load current.

To see the influence of the number of conductors n_2 in the auxiliary phase, let us plot the curves (fig. 2) in function of $q = \left(\frac{k_1 n_1}{k_2 n_2}\right)^2$, or, in other words, in function of n_2.

For each value of q the maximum torque can be obtained with a resistance in the rotor, for which the current in the main phase is the one given by the formula already seen $A F = \frac{270}{\sqrt{1 + q}}$. Having thus fixed the point F in the diagram, we can find and plot the values of the torque, the K.V.A. absorbed by the choking coil $\frac{R L}{F R}$. F L . S, the power wasted in the starter L T^1 . S and the maximum current in one leg of the starter.

* If we do not neglect the copper loss in the primary and the iron loss the formula will still hold good, provided that we call P_1, P_2, the powers wasted in the rotor considered as the secondary of the two stator phases, and β the angle of phase difference between the secondary currents.

† To arrive at this expression the actual M.M.F. curve has been replaced by its fundamental harmonic.—See Arnold's "Die Wechselstromtechnik," Vol. III.

In regard to this last item, we notice that each phase of the polyphase rotor carries a current depending on its position with respect to the stator fields and their phase relation. It can be proved that the maximum current to be expected in one of the phases occurs when $\beta = 0$, and is given by $\sqrt{(I_0^{1})^2 + (I_0^{11})^2}$, where I_0^{1}, I_0^{11} are the currents given by (1).

The rating of the starter must be done on the basis of this maximum current, and this fact constitutes a draw back of starters for single-phase motors, since not being balanced, they must be rated for more power than they waste. From the curves we see that the maximum torque obtainable with 270 amps. is 60 kg. metres, and corresponds to $q = 2$ or $n_2 = 96$.

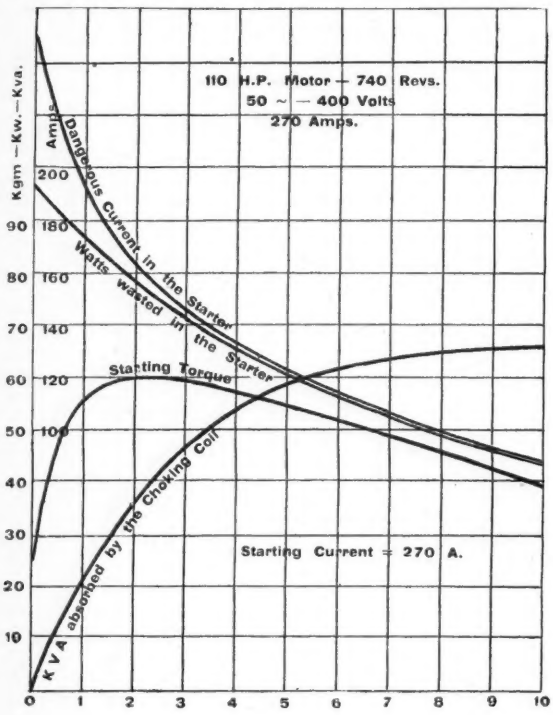

110 H.P. Motor — 740 Revs.
50 ~ — 400 Volts
270 Amps.
Kgm — Kw. — Kva.
Amps.
Dangerous Current in the Starter
Watts wasted in the Starter
Starting Torque
K V A absorbed by the Choking Coil
Starting Current = 270 A.
0 1 2 3 4 5 6 7 8 9 10
10 20 30 40 50 60 70 80 90
100 120 140 160 180 200

Fig. 2.

For increasing values of q the power wasted and the maximum current in the starter are decreasing, while the K.V.A. absorbed by the choking coil are increasing; the contrary happens if q decreases. In other words, by using more or less turns in the auxiliary phase we increase the size of the starter or the size of the choking coil.

It will be generally advisable to calculate the turns in the auxiliary phase to get the maximum torque. As a rule this number is about half of the number of turns in the main phase.

PREMIER ACCUMULATOR TESTS.

In our issue of April 6th last we gave a full account of the Premier accumulator, and of comparative tests to which it had been subjected, the results being very favourable to it. A complete series of tests has now been carried out at the National Physical Laboratory on this type of cell, and we have before us the report signed by Dr. R. T. Glazebrook, director of the Laboratory, which we reproduce below :—

Report of Test on Accumulator by the Premier Accumulator Co.

Three cells, each of five plates, in glass boxes were tested in series :—(1) For capacity and efficiency at a nominal 10-hour rate, and for capacity at nominal 5, 3 and 1-hour rates. (See Table I and Curves 1, 2, 3 and 4.*). The charging rate during the tests was 21 amperes.

* These curves are here omitted, as being of far less interest than those taken after heavy discharges and short-circuits, which are reproduced in the adjoining column.

(2) The cells were given a number of very heavy discharges (Table II), the charging rate being 20 to 40 amperes.

(3) Retested for capacity and efficiency at nominal 10-hour rate

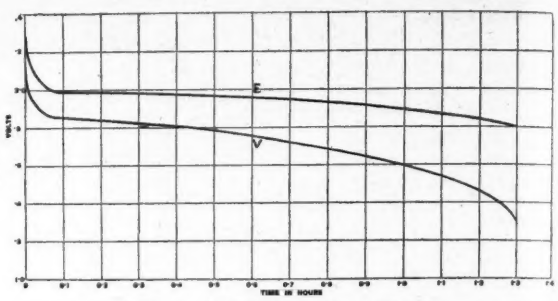


Fig. 5.—Discharge at 78 Amperes.

and for capacity at nominal 5, 3 and 1-hour rates (see Table III and Curves 5, 6, 7 and 8). The charging rate during these tests was 21 amperes as before.

The discharge was in each case stopped when E, the voltage on

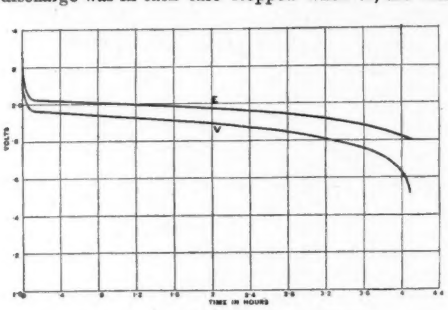


Fig. 6.—Discharge at 36 Amperes.

open circuit, had fallen to 1·8 per cell, and the charge when E had reached 2·37 per cell, V, the voltage on closed circuit, being 2·8 per cell at the 21-ampere charging rate.

When making the efficiency tests the cells were in each case subjected to a number of charges and discharges until they had

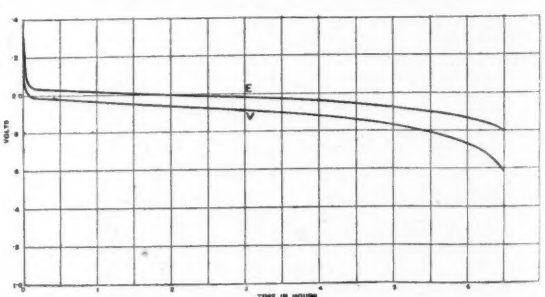


Fig. 7.—Discharge at 26 Amperes.

reached a steady state, the mean of the last three being shown in the curves.

The specific gravity of the acid when the cells were fully charged was 1·205 to 1·210.

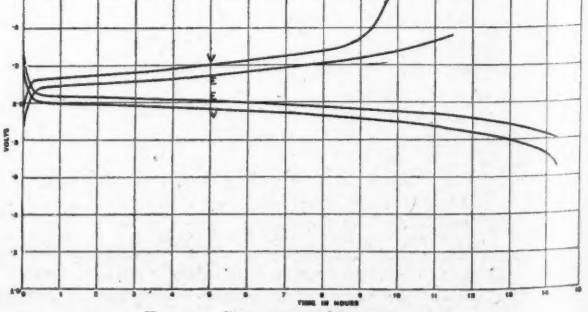


Fig. 8.—Charge at 21 Amperes; Discharge at 15·5 Amperes.

The tests extended in all over a period of four months, and it will be noted that as a result of the abnormally heavy discharges

the cells had an increased capacity of about 25 per cent., while the efficiency was slightly lower than at first.

On examination at the conclusion of the tests, one positive plate in each cell was found to be slightly buckled, although not sufficiently to cause a short-circuit. In all other respects the cells were quite normal in appearance.

Dimensions of plates, *one side of plate only*:—

Positive, $9\frac{3}{8}$ in. × $9\frac{7}{8}$ in. × $\frac{3}{8}$ in. = 96·3 sq. in. per plate.
Negative, $9\frac{3}{8}$ in. × $9\frac{7}{8}$ in. × $\frac{1}{4}$ in. = 96·3 ,, ,,
Total area, one side only of plate = 481·5 sq. in.
Positives only = 192·6 ,,

Table I.

Curve No.	1	2	3	4
Rate of discharge, amperes	15·5	26	36	78
Capacity, ampere-hours per cell ...	178	142	122	79
Ampere-hours per 100 sq. in. of plate	37	29·4	25·3	16·4
,, positives only ...	92	73·5	63·3	41
Initial V per cell	2·18	2·12	2·10	2·06
Final V per cell	1·65	1·61	1·53	1·34
Mean V per cell	1·92	1·87	1·81	1·68
Watt-hours per cell	342	265	220	133
Watt-hours per 100 sq. in. of plate	71	55	45·5	27·6
,, positives only	177	137·5	114·5	69

Rate of charge, amperes, 21.8. Ampere-hours per cell, 189. Initial V per cell, 2·02. Final V per cell, 2·78. Mean V per cell, 2·30. Watt-hours per cell, 435.

Efficiency at 15·5 amperes discharge, and 21 amperes charge—

Ampere-hour ... ... 94 per cent.
Watt-hour ... ... 79 per cent.

Table II.

When the cells were short-circuited, the initial current was 1,600 amperes. At the end of three days, the cells were still giving 2 amperes. The number and ampere rate of the discharge is as follows:—

9 times at 80 amperes
9 ,, 150 ,,
4 ,, 50 ,,

Dead short-circuit for three days.
Dead short-circuit for two days.
Dead short-circuit for one day.

Table III.

Curve No.	8	7	6	5
Rate of discharge, amperes	15·5	26	36	78
Capacity ampere-hours per cell ...	222	169	147	101
Ampere-hours per 100 sq. in. of plate	46	35	30·5	21
,, positives only ...	115	87·5	76·3	52·4
Initial V per cell	2·18	2·12	2·10	2·07
Final V per cell	1·65	1·58	1·51	1·3
Mean V per cell	1·91	1·87	1·85	1·70
Watt-hours per cell	420	316	272	172
Watt-hours per 100 sq. in. of plate ...	87·5	65·5	56·5	35·7
,, positives only	219	164	141	89

Rate of charge, amperes, 21; ampere-hours per cell, 240; initial V per cell, 1·97; final V per cell, 2·80; mean V per cell, 2·26; watt-hours, 542.

Efficiency at 15·5 amperes discharge and 21 amperes charge—

Ampere-hour ... ... 92·5 per cent.
Watt-hour ... ... 77·5 per cent.

(Signed) R. T. Glazebrook, *Director.*

August 3rd, 1906.

The foregoing results are noteworthy for several reasons. Not merely was the harsh treatment described in Table II survived, but the capacity of the cells was very materially increased thereby, albeit the efficiency fell a trifle. The short-circuiting was no figure of speech, for the initial current was no less than 1,600 amperes, and the duration of the longest short-circuit test three days (72 hours). Moreover, the cells were discharged at nearly ten times their normal (10-hour) rate on nine occasions, besides enduring many other severe discharges. To pass through such an ordeal, and to come up smiling at the finish asking for more, is a performance of no small merit.

It is interesting to compare the results obtained at the laboratory with those put forward by the makers in the first instance. Unfortunately, the tests quoted in our article above mentioned are not directly comparable with the present series, the cells being of a different size, and being discharged to different limiting voltages; but comparison may be made between the curves given in the company's catalogue and those obtained under Dr. Glazebrook's control. The former, discharging at 15·5 amperes to a final voltage of 1·85 volts, shows a capacity of 192 ampere-hours, and the latter, under the same conditions, gives 193·7 ampere-hours. In both cases the cells had been subjected to short-circuits and other severe treatment. The following examples may also be cited, the Premier type B cell being tested in both cases:—

	Catalogue.	Nat. Phys. Lab.
Capacity at 15·5 amperes—ampere-hours	155	193
,, 25·5 ,, ,,	127·5	—
,, 26 ,, ,,	—	146·25
,, 32·5 ,, ,,	97·5	—
,, 36 ,, ,,	—	121·4
,, 78 ,, ,,	78	79
Average efficiency, per cent.	92	92·5

It would appear, therefore, that the company's claims were well within the mark, while the ability of the cells to stand rough treatment is clearly shown.

THE CONTINENTAL ELECTRICAL ENGINEERING INDUSTRY.

Improvement in German Undertakings.

The Norddeutsche Seekabelwerke Gesellschaft (North German Marine Cable Works Co.), of Nordenham, which is a subsidiary of the Felten & Guilleaume Co., appears to be practically a private concern, as two shareholders represented the entire ordinary capital of £300,000 at the last meeting. The report then presented stated that the works were fully employed into the autumn of 1905, mainly on the construction of the second section of the Shanghai-Yap cable. In addition, the company completed the Constantza-Constantinople cable for the East European Telegraph Co. and the Balikpapan-Macassar cable for the Dutch-Indian Government, together with a quantity of stock cable for the latter Government, the German Government, and the German-Netherlands Telegraph Co., and also a short river cable for the German Admiralty. On the conclusion of manufacturing operations, which took place at the end of September, it was necessary to discharge the larger portion of the workmen, while the remainder were employed on preparatory and cleansing works until the close of the year. The financial results are as follows:—

	1905.	1904.
Ordinary share capital ...	£300,000	£300,000
Net profits	£199,600	£90,156
Dividend, per cent.	15	8

The net profits were arrived at after having provided £52,933 for depreciation as compared with £53,948 in 1904. The report also referred to the operations of the cable steamers, and stated that the company made offers to various foreign companies and Governments during 1905, although these only led to the orders already mentioned for the Dutch Government. In German interests the company has worked out comprehensive cable plans, which the directors hope will be carried out in part in the near future. It was reported in June, 1906, that the company had received an order from the Turkish Post and Telegraph Administration for the supply and laying of a cable between Siel-el-Bahr and the island of Imbros.

The Felten & Guilleaume-Lahmeyer Works Co., which will be remembered as an amalgamation of the Karlswerk, of Mulheim, and the manufacturing works of the Lahmeyer Co., of Frankfort, has a paid-up capital of £2,600,000, which was wholly represented by eight shareholders at the last meting. As the Lahmeyer dynamo works were only taken over by the amalgamated company on March 31st, the directors' report for 1905 only deals with the acquired business for a period of nine months. The gross profits for 1905—that is, for twelve months in the case of the one, and nine months in that of the other undertaking—amounted to £602,646, as compared with £343,181 realised by the Karlswerk alone in 1904. After meeting general expenses, and writing off £90,016 for depreciation, the accounts show net profits of £323,816 for the combined enterprise as contrasted with £191,683 in the case of the Felten & Guilleaume Co. alone in 1904. The latter then declared a dividend of 8 per cent., while the rate paid for 1905 is 10 per cent. on a capital of £2,600,000, representing the amalgamated works. The report, in referring to the Karlswerk, states that excepting for slight fluctuations, all departments were employed to the limit of their capacity throughout the year, and in general the prices obtained corresponded to the rise in the cost of raw materials. A similar state of activity prevailed at the Frankfort dynamo works, and large extensions are to be carried out there during 1906, but the sale prices last year were unsatisfactory, especially for plant for installations of small and medium sizes. The report also mentions that a further satisfactory development took place in the foreign organisation during the year.

The Electricitäts Gesellschaft vorm. W. Lahmeyer & Co. may be regarded as a kind of trust, seeing that the manufacturing departments were transferred to the Felten & Guilleaume-Lahmeyer Works Co. some time ago. At the recent meeting of the shareholders in the former company a dividend was declared at the rate of 7 per cent. for 1905, as compared with 5 per cent. in the previous year. The financial position is as follows:—

	1905.	1904.
Share capital	£1,000,000	£1,000,000
Bonds, $4\frac{1}{2}$ per cent.	875,000	700,000
,, 4 per cent.	92,000	93,000
Net profits	80,150	63,627
Dividend, per cent.	7	5

It would appear from the amount of the company's shareholding in the Felten & Guilleaume-Lahmeyer Co. and the dividend paid by the latter for 1905, that slightly over one half of the gross profits of the Lahmeyer Co. were derived from the combination in question. The balance emanates from the company's other investments and own electricity works in different parts of Europe. The shares held in the combination comprise £750,000 fully paid and £100,000 in shares upon which 25 per cent. has been paid.

The report of the Akkumulatoren Fabrik Gesellschaft, of Berlin, which was adopted at the recent general meeting, first refers to the increase in the share capital for the provision of funds to buy up competitors and take a larger interest in the Russian and English Tudor accumulator companies. During 1905 the electrical industry continued to develop in a favourable manner, and the net turnover of the company's factories at Hagen and Berlin and at Hirschwang, near Vienna, made a considerable advance, notwithstanding the continued underselling practised by rivals. The trading results are briefly as under:—

	1905.	1904.
Ordinary share capital	£400,000	£312,500
Gross revenue	253,850	178,780
Depreciation	31,221	16,983
Net profits	59,950	47,020
Dividend, per cent.	12½	12½

The directors mentioned that the undertakings in which the company is interested, are in course of favourable development, the Russian branch company not having been influenced in any way by the late war. The premium reserve fund for battery maintenance, which is a fund for the insurance of consumers with a view to the limitation of the cost of maintenance, rose from £14,300 in 1904, to £126,700 in the past year. It was necessary at the beginning of 1906, to increase prices owing to the advance in the quotations for raw materials, although the existence of long term contracts prevented the augmentation from being of general application for the time.

The shareholders in the Mix & Genest Telephone and Telegraph Works Co., of Berlin, approved the payment at the last meeting of a dividend at the rate of 8 per cent. on a share capital of £180,000, and of 4 per cent. on £70,000 new capital for 1905. According to the report presented on that occasion the volume of business transacted during the year again exhibited a considerable advance, although the results were prejudiced by the greater cost of raw materials, and the increase in wages. It was only possible at the end of the year to make a corresponding rise in prices, and this was accomplished by virtue of arrangements made with other firms in the trade, the effects of which will only be felt in the present year. The demand in the first few months of 1906 is stated to have further improved, and no apprehensions are entertained as to serious disadvantages arising from the operation of the new treaties of commerce.

The Deutsche Kabelwerke Gesellschaft (German Cable Works Co.), of Rummelsburg, has increased its share capital from £100,000 to £175,000 for the purchase of land adjoining the works for the purpose of extensions. In the course of the directors' last report, which refers to a period of seven months, it is mentioned that the sales were 50 per cent. greater than in the corresponding period, and that the English business had further increased. The accounts for that period show net profits of £12,917, as compared with £12,918 in the whole of the preceding year, and a dividend has been declared at the rate of 7 per cent. per annum, as against 5 per cent. in the previous year. It appears that the company's investments are booked at £13,137, which sum includes the interest held in the Union Cable Co., of London.

The Accumulator and Electricity Works Co. (late W. A. Boese and Co.), of Berlin, which recently embarked upon a war of prices in the stationary battery trade, now has an ordinary share capital of £2,950, preference shares of £222,050, and 4,441 "profit shares." This arrangement is due to alterations made in the capital which, in 1902, totalled £225,000 in ordinary shares. It is stated in the directors' report for 1905 that the turnover materially increased, although the net profits only amounted to £2,875, as compared with a loss of £2,474 in 1904. In these circumstances it has again not been possible to make any distribution on the share capital. The profit shares have, however, been paid 8s. per share. The company is also interested in certain lighting stations, and in the promotion of electric lighting of railway trains.

French and Other Foreign Works.

The Société d'Electro-Métallurgie de Dives, which is largely concerned with the production of copper, had a turnover of 8,800 tons in 1905, as compared with 8,000 tons in the preceding year. The accounts indicate net profits of £23,880 as compared with £26,260 in 1904, and the entire sum, as in former years has been allocated to the reserve and depreciation funds. The special reserve fund, the object of which is to keep the book value of the copper stocks at £55 per ton, advanced from £32,800 in 1904 to £72,000 last year in consequence of the increase in the price of copper.

The A.E.G.-Union Electrique, of Brussels, which has just increased its share capital from £80,000 to £100,000 by the issue of 2,000 new £10 shares, has issued a report for the first year since the taking over of the undertaking of the Société Générale Belge d'Electricité. It relates to 1905 and shows, after writing off £2,300 for the purpose of depreciation, net profits amounting to £8,980. This sum has allowed of the payment of a dividend of 13s. 6d. per share on the ordinary shares and 5s. per share on the founder shares. During 1905 the company transacted good business and had considerably more orders on hand at the end of the year than at the close of 1904. The central station at Ghent was completed before the stipulated period. The number of the company's consumers at Brussels continued to grow and the erection of a new generating station was necessary.

The Société Franco-Suisse pour l'Industrie Electrique, of Geneva, is an investment company which was formed in 1898, and has as ordinary share capital of £1,000,000 and obligations amounting to £400,000. It is stated in the directors' report for 1905 that no special transactions were concluded during the year, which was devoted to the execution and completion of the undertakings in which the company is interested. Among these are mentioned the Grenoble and Rhone Hydraulic Power Companies, the West of Paris Electricity Co., the Havana Electric Railway Co., and a number of other electric lighting works and tramways, and electro chemical enterprises. After providing £12,000 for redemption and depreciation, the accounts reveal net profits of £35,098, which sum has permitted of the payment of a dividend of 3 per cent. on the share capital, as compared with 2 per cent. in 1904.

The Austrian Felten & Guilleaume Co., of Vienna, has a share capital of 7,000,000 kronen, the preponderating portion of which is held by the parent concern in Germany. During 1905 the sales, with the exception of lead-covered cables, were higher all round, although prices remained unchanged and it was not possible to utilise the plant to its full extent. The company was able to cover its requirements in metals at an appropriate period before the large advance in prices commenced in the past summer. The net profits rose from 1,169,143 kr. in 1904 to 1,467,729 kr. last year, and a dividend of 12 per cent. has been declared as against 10 per cent. in 1904.

Among other Austrian companies may be mentioned Ganz & Co., who have declared a dividend at the rate of 110 kronen per share for 1905; the A.E.G. Union Electricity Co., 4 per cent, and the United Glow Lamp and Electricity Co., of Buda-Pesth, 8 per cent.; while the Siemens-Schuckert Works Co. has refrained from making any distribution for 1905.

CORRESPONDENCE.

Letters received by us after **5 p.m. on Tuesday** *cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.*

The Comparative Value of Comparisons.

My attention has been called to an article in your issue of June 29th under the above heading, in which you deal with a table given in the paper read by me before the M.E.A. Convention. If you had read the article I wrote last year in the *Electrician* on this subject, you would have found that I had dealt with this comparison of coal consumptions in electricity works with marine practice rather more fully, and the only reason I reproduced the table in my paper of this year was to bring out the point that the difference is not due so much, if at all, to the difference in efficiency in the boilers, but to the difference in the steam consumption. I did not think it necessary to point out to a meeting of electrical engineers the difference in conditions, load factor, &c., as this question has been dealt with so often that I felt justified in assuming that every engineer at the meeting would be quite capable of understanding the difference in the conditions without any assistance from me.

In stating that "it is doubtful if any electricity works can compete in steam consumption with the best results obtained in ships" I meant, although possibly I did not explain myself clearly enough for you to understand, that the conditions prevailing prevented energy being generated as efficiently in the every-day running of an electricity works as in test runs on board ship, and I understand that this is also your opinion.

The whole question of steam consumption in an electricity works is a great deal more complicated than the question of the steam consumption of a single set, and superheating or improved vacuum will only help matters to the extent of, say, 10 or 20 per cent.

Two years ago a table was given by Mr. R. S. Downe in his paper before the M.E.A. Convention, 1904, in which he gave the coal consumption at 31 electricity works. The lowest coal consumption recorded was 3·65 lb., and the highest 15·4 lb. per unit. The former figure was for a plant of 11,000 KW. capacity, the latter for one of 3,000 KW. In my table I gave the coal consumption of the "Diamond" as 4·7 lb. per unit, the I.H.P. of the engines being 10,000 as compared with 7·1 lb. for Grimsby for a load of 211 KW. You will notice that there is a very much greater difference in the coal consumption in the first case, notwithstanding that the difference in the size of the installations is not nearly so great.

In Mr. Downe's table mentioned above, only four stations used less than 5 lb. The whole discussion on this paper turned on boiler house economies, and the point that I have tried to bring out is, that it is not nearly so much a question of boiler-house economy as economy in steam consumption.

Perhaps it was not intended that your article should be taken seriously, I was certainly very much amused with it, but it is a pity that the writer was so pleased in discovering the small size of the Grimsby undertaking (clearly stated by me in the table) that he twice called it "mammoth," once would have been more artistic; and that he became personal, which, besides not being good manners, is, I have always understood, only resorted to as a support for a weak argument.

W. A. Vignoles.

Grimsby, *August 13th*, 1906.

An Attempt at Corruption.

I have read with some interest the particulars given in your Notes on the above in the issues of the 3rd and 10th inst. You end by saying that you hope that incident constitutes an exception. I fear that many others besides myself will be able to disabuse your mind on this point. I have on several occasions had similar offers made to me, sometimes in writing, sometimes by word of mouth. The last occasion occurred as recently as July 25th, 1906, as you will see by the enclosed letters and copies of my replies, dated July 24th, 25th, 26th and 27th.

I know of one case where as much as 10 per cent. was offered on the contract price (amounting to about £3,000) for certain machinery and appliances.

A. S. E. Ackermann.

London, S.W., *August 14th*, 1906.

The following are extracts from the correspondence in question :—

If you could see your way to recommend our instruments or include them in specifications you may have in hand, we should be delighted to reserve you a consulting fee of two guineas on every order we book in consequence of your recommendation, the actual work, of course, being done by us.

In reply to your letter of 25th inst., I regret that you are still under a misapprehension. I am in the habit of receiving my fees from my clients, and never accept commission from manufacturers or contractors, so that if you do not wish to prejudice me against your apparatus, I must ask you to apologise for the suggestion contained in your letter.

We have to acknowledge receipt of your favour of yesterday's date, and are sorry if we should have put our proposal in such a way as to meet with your disapproval. We do not by any means wish to suggest that you should accept fees from us in cases where you receive these from your clients.

[We regret to say that this and other communications which we have received indicate that the canker of bribery and corruption is eating deeply into our commercial organisation. The fact that such offers are made even to firms and individuals of repute proves, if proof were needed, that they are not always refused; and the upright suffer through the sins of the corrupt. A man cannot accept fees with both hands and remain an honest or respectable person.—EDS. E.R.]

Municipal Muddling.

I should like to draw the attention of your readers to an example of the unbusinesslike methods, which are now so common amongst those we elect to manage our affairs and to spend our money.

Some time ago the Woolwich Borough Council advertised in the ELECTRICAL REVIEW for a Commercial Assistant for their Electrical Department. About 200 applications were received, and from these 11 candidates were selected and asked to attend a meeting of the Electricity Committee at 7 p.m. on July 12th. At this meeting the candidates were kept till 11 p.m., and six of them were "short listed"; they were then informed that the Establishment Committee had dissolved and would make the appointment at the next meeting, of which due notice would be given.

The second meeting was called for 5 p.m. on July 26th. The candidates were kept waiting till 6.30 p.m., and then only three were interviewed, and the others were informed that they would be called to another meeting later on together with those already interviewed.

To-day the following letter was received by these candidates from the Town Clerk :—

"Referring to your application in answer to the advertisement of my Council for a Commercial Assistant in the Electricity Department, I have to inform you that after further consideration of the matter, the Council have now decided to take no further action in regard to the advertisement issued by them, and you may now consider the same as having been cancelled."

Of the six candidates short-listed, at least half had to come up from the provinces. To those attending both meetings travelling expenses were paid, and 10s. hotel expenses were incurred. Further, of the 11 original candidates, where present employers were quoted, these were written to for references.

The net result of the whole business is as follows :—The ratepayers of Woolwich will have to find some £20 to £30 on account of nothing, whilst probably eleven men in comfortable situations, who were attracted by the glamour of a municipal appointment, have been unsettled and become objects of suspicion to their employers.

With regard to the thoroughly unbusinesslike method of dealing with the candidates, comment under the circumstances is superfluous; if the candidates had read their papers carefully they would have known what to expect, but the writing to candidates' employers in the premature and wholesale manner described, is nothing short of a scandal. A man who applies for a position generally assumes that his application will be treated in confidence, until such time as the confirming of his engagement merely depends on a formal reference to his employers. The action of the Committee, who apparently do not know their own minds, is, to say the least, most reprehensible, and should serve as a warning to intending candidates for future appointments at Woolwich.

Once Bitten, twice Shy.

Tramway Accidents.

The numerous accidents which have recently occurred, make those responsible for the safe working of their undertakings carefully consider every detail which could prevent an accident, or minimise the possibility of one. The following points have occurred to me as being worth consideration :—

1. The operating of the rear brakes, whether hand or slipper, is in an emergency, usually left to the conductor, and it is a matter of the utmost importance that there should be an absolutely clear understanding between the motorman and conductor as to the applying or removing of these brakes, and distinguishing between them.

The conductor must act entirely under the motorman's instructions, if not he may do the very thing to nullify the motorman's attempt to stop the car. A car may be running away, the conductor applies the rear hand brake, and the motorman is relying on his electric brake. We thus have a combination which has been responsible for many an accident. Again, a conductor may have been signalled to apply one or both of the rear brakes, and the motorman may find it imperative that one be removed, owing to the wheels being locked from rear hand brake. Unless he has some clear means of signalling this removal, his electric brakes, both rheostatic and track, are valueless.

To improve the signalling arrangements between motorman and conductor, I am fixing an additional foot pedal gong at each end of the car, the note being quite distinct from the ordinary service gong so that its use always calls for immediate attention. The applying and removal of either hand or slipper brake is signalled by means of different numbers of strokes on this gong. Any signalling between motorman and conductor by the ordinary gong cannot be made distinctive enough, and to depend upon any hand signalling with, perhaps, people standing up inside the car or windows obscured, cannot be considered a satisfactory method.

E

2. In many car designs a catch is provided for fastening the door at the motorman's end, so that this is entirely under the control of the motorman. This arrangement appears to me to be quite unnecessary, and, in fact, a possible danger under certain conditions, as should a motorman be ill or require assistance in any way, it is impossible for the conductor or anyone else to get through the car to him without smashing the plate-glass windows, and the time so lost might be of the greatest consequence. To get over this difficulty I have drilled holes in the wood work so that one's finger can be pushed through from the inside of the car, and the outside catch lifted.

3. On routes where steep inclines have to be dealt with, it is not always customary to give the conductor means for working the rear sanders, or to make it a rule that no conductor shall leave the platform while on such inclines. One is aware how frequently the brake power is dependent upon the application of sand; it should, therefore, be possible to apply this immediately in the event of the car running backwards, or being driven backwards. Traffic requirements, such as attending to fares, will not always allow of the conductor remaining on the rear platform, and any short period of time lost in the application of rear sand in an emergency might have very serious consequences. I consider that in such cases the motorman should be provided with an additional sand pedal for operating the rear sanders. It will be found that this can be very cheaply and readily carried out. It would be well if all makers designed the sand pedal so that it could be ready for quick application from the rear platform, and yet not be a source of danger to passengers using this platform.

P. J. Pringle.

Tramways and Electricity Departments,
Burton-on-Trent.

August 16th, 1906.

A Curious Experiment.

I have never seen an account of a similar experiment to the one I give below, and as it seems to me worthy of note I give you particulars.

I took 20 No. 16 copper wires about 1 ft. long. One end I immersed in water, the other I heated to white heat with a large blow lamp.

I took the P.D. between the ends with an ordinary Weston meter, and obtained no reading.

I now placed the wire in a strong magnetic field, about 6 in. of the wire being under the influence of magnetism.

I again took the P.D. between the ends, and found it to be between $2\frac{1}{2}$ and 3 volts.

I have no instruments or apparatus at my disposal sufficiently delicate to give reliable results, but I think the experiment worth repeating by those who have such.

This experiment appears to me to be a variation of the old experiment, where a slight P.D. is obtained by heating the junction of metals under ordinary conditions, that is, in the earth's field. If an artificial field is employed the P.D. can be increased.

I observed, also, a momentary reverse P.D. when the metal was allowed to cool to a uniform temperature.

G. Vaughan.

August 12th, 1906.

The Single-phase Induction Motor.

Having been abroad for some time I have not been able to reply before to Mr. Fynn's letter of July 20th. He says he has found some difficulty in following my last letter, and, as a matter of fact, I must admit my lack of clearness to explain why his confutations do not answer quite to my arguments. I will try now to recapitulate in few words and develop what I have already said.

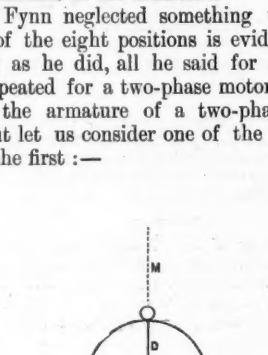
Mr. Fynn wants to prove that in a single-phase induction motor without commutator the no-load current is equal to the magnetising current. To prove this he takes a two-phase wound motor running at synchronism in an alternating field, and he assumes that as a result of this rotation there are two fluxes equal and at 90° in space and time. Although not quite satisfactory for one who wants to understand a new theory, still this assumption is quite correct, and I have nothing to say against it.

The point where I do not agree any more with Mr. Fynn comes when from this fact taken as a cause he wants to go back and find the currents in the rotor winding. I maintain that this way of tackling the problem is not rational, as the two 90° fluxes (or the resulting revolving flux) are the resulting phenomena determined by the currents in the armature, which in consequence cannot be found as an effect of the two 90° fluxes.

As an indirect proof of the inexactness of this method of setting the problem, I said that it would lead to conclusions which can hardly be accepted. In fact, either with the revolving flux theory, or with the simple trigonometrical formula I showed in my letter, one comes to the conclusion that there are no currents in the armature. Then my question, "How has the motor flux been produced?" Mr. Fynn seems to have forgotten that I found the non-existence of currents in the armature without the help of the rotating flux theory, and instead of accusing his method of treating the problem as guilty of such an absurd result, he accuses once more the rotating flux theory, and he finds in my question, "How has the motor flux been produced?" a new reason to condemn it.

Having faith in his plan of attack, and knowing he must find currents in the armature, Mr. Fynn repudiates all the other ways leading, to the non-existence of current, and builds up a new system of investigation in which he considers eight positions of the armature. Although unnecessarily long, this method, which only avoids the use of a differentiation, if applied without any omission, will naturally bring one to the same result—that is, the non-existence of currents in the armature.

That Mr. Fynn neglected something when he applied his method of the eight positions is evident from the fact that, starting as he did, all he said for a single-phase he could have repeated for a two-phase motor, and find that at synchronism the armature of a two-phase motor carries currents. But let us consider one of the eight positions—for example, the first:—



Let us suppose with Mr. Fynn that in this position is M = 0, M_1 positive maximum. He finds that in C the current is nil, and in D it is maximum. To this last conclusion he arrives by saying: M also produces E R in D by rotation, when M = 0, then E R = 0; but i_2 lags 90° behind E R and reaches a maximum for E R = 0. Because E R is opposite in phase to M, the maximum reached by i_2 will be positive and M_1 = positive max.

That is quite correct, but what about the transformer action of M_1 in D by which an E.M.F. E T = 0 will be induced, and a current which is a negative max. will annul the previous one?

In conclusion, I think that if one does not want to apply the method of Ferraris, the best and simplest method is the one very well known, which I have outlined in my last letter, where, I must say, I never mentioned, as Mr. Fynn believes, that the E.M.F.'s set up in the polyphase-wound rotor are of the same frequency as the supply.

Referring now to my diagram of the single-phase motor with commutator and brushes short-circuited at 90 electrical degrees, I am disappointed to see that Mr. Fynn has nothing to say besides his assertion that a simple test will prove the power factor to be not a maximum at standstill.

I should be very pleased to see some tests proving this fact and the other regarding the equality of magnetising current and no-load current in a single-phase motor without commutator.

Experimental facts of such a nature would be of great interest to me, as they are not in agreement with the theory I know and my personal observations.

N. Pensabene Perez.

Wolverhampton, *August 14th*, 1906.

A.C. Connections.

We are supplied with current by the local supply company. They transmit it from their generating station at 11,000 volts, and at their sub-station here transform it down to two voltages, viz., 440 and 2,200.

On the 440 or low pressure side there is a bank of three transformers, each single-phase, but on the high-pressure side (2,200) they have only two connected as in fig. 1.

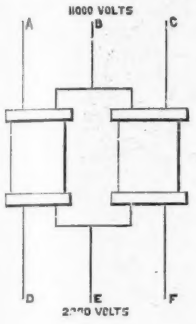


FIG. 1.

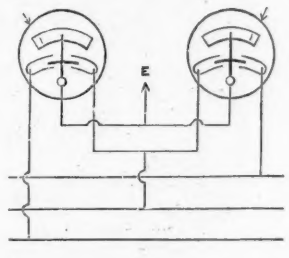


FIG. 2.

I should like to know whether we receive three-phase current or three-wire two-phase.

We also have on our 2,200-volt switchboard two static ground detectors, as shown in fig. 2.

Is it possible that the supply, if two-phase, would affect them? They have been deflected since their connection to the spots indicated by the arrows.

Sydney W. Richards.

Pontypridd, *August 12th*, 1906.

[The supply company has a variety of systems in use; the 11,000-volt supply is three-phase. Apparently only two of the three phases are in use in the case cited by our correspondent, but these do not constitute what is generally known as a two-phase supply, the phases being at 120° displacement instead of in quadrature. The deflection of the ground detectors indicates an earth on the middle wire.—EDS. E.R.]

Radium.

The argument used to support the proposition that the salts of radium, and the element itself, disintegrate—namely, that it gives off helium, would be more satisfactory if helium did not already exist in the surrounding atmosphere. Is it not just possible that radium sorts it out from this atmosphere? And absorption of gases generally means rise of temperature. But of the mechanism of absorption, and the sorting action accompanying it, we know practically nothing, not even excepting the case of our familiar friend charcoal.

J. C. R.

August 16th, 1906.

[Our correspondent's suggestion is discounted by the fact that helium is given off, not absorbed; if it were present in radium in the occluded form, it would be detected by the spectroscope. Moreover, it is given off by radium enclosed in sealed tubes; if it is derived from the atmosphere, therefore, it must be capable of passing through glass.—EDS. E.R.]

Purchase of the Thury Patents.

Will one of your corrrspondents kindly give me the name of the English firm that has purchased M. Thury's patent high tension direct current inventions?

Central Power.

Industrial Power Supply from Municipal Stations.

Owing to absence on holidays, I have only just seen that Mr. Long, in a letter to your paper of August 10th with reference to an article of mine in an earlier issue, condemns my conclusions as erroneous, and credits me with an assumption which, in his opinion, entirely invalidates my argument.

I would point out that I have not stated, nor do I think implied, that extensions to a power station which has cost £70 per KW. would necessarily entail an expenditure of this amount.

What I have implied is that extensions to an undertaking, already heavily capitalised, and probably put down without contemplation of large development, are likely to involve heavier charges than can be defrayed out of the slender revenue of 6d. per unit sold.

In the few stations which are so fortunately situated as to be able to install extra plant by the mere replacement of old machinery by new, without alteration and extension to site, buildings, &c., I quite agree that the cost would be comparatively small, although in these cases the unpaid-off capital on account of the discarded plant would in many instances become a charge on the revenue, sufficiently great to wipe out the small margin of profit for a few years.

The last two paragraphs of Mr. Long's letter are, I think, exactly corroborative of my own statements in the article in question.

F. H. Corson.

Over Haddon, *August 18th*, 1906.

Wireless Telegraphy.

In fulfilment of my promise in your issue of the 17th inst., I am now able to supply the reference to the date of the first publication of a description of my copper disk galvanometer for alternating currents, for which Prof. R. A. Fessenden asked in the ELECTRICAL REVIEW of August 10th. I find that a brief mention of it was made in the *Electrician* of March 25th, 1887, Vol. 18, p. 442, under a report of the Proceedings of the Physical Society of London, and a fuller description by me appeared in the *Electrician* of May 6th, 1887, Vol. 18, p. 561.

In this last account a diagram of the instrument is given, and an explanation of its action. This description anticipates the issue of Prof. Elihu Thomson's U.S.A. patent, No. 363,185, on May 17th, 1887, although it does not anticipate the filing of his application on January 26th, 1887.

I may, however, say that (as stated in the *Electrician*) I had the instrument in use and had shown it to friends before the beginning of 1887. Hence I think I am entitled to claim the independent discovery of the principle of the instrument, although perhaps not the priority from a purely patent point of view.

At the time when I exhibited and described this instrument there had not been, as far as I am aware, any published account of the beautiful experiments of Prof. Elihu Thomson on electro-magnetic repulsion. These experiments were exhibited by me for the first time in England, in May, 1890, at the Society of Arts and at a Royal Society soirée, but my copper disk galvanometer was shown at a Royal Society soirée in May, 1887. Accordingly, although no questions of patent priority are involved (as my instrument was not patented), I trust that the evidence is sufficient to permit me to be granted the credit of having discovered independently the orientation of a copper disk in an alternating magnetic field, and of having applied it to the construction of an instrument which has more recently been applied by Prof. Fessenden in wireless telegraphy.

It may be noted that Prof. G. W. Pierce in his interesting researches on "Resonance in Wireless Telegraph Circuits" (*Physical Review*, Vol. 19, p. 196, 1904; Vol. 20, p. 220, 1905), also employed a disk of silver paper suspended by a quartz fibre with a coil of wire traversed by electrical oscillations as a means of detecting electric waves, and kindly refers to me as the originator of this form of alternating current galvanometer. My object in writing these few lines is simply to answer Prof. Fessenden's question, and not to claim for myself more than is now generally accorded in the matter of the discovery of electro-magnetic repulsion with which Prof. Elihu Thomson's name is always most rightly connected.

J. A. Fleming.

London, *August 21st*, 1906.

LEGAL.

Manchester Tramway Accident.

A Collision on July 23rd, between a Salford Corporation tramcar and a lurry belonging to James Hancock, a Manchester carrier, led to a claim by the Corporation for damages in the Manchester County Court last week. The Corporation alleged that, owing to the negligence of the lurry driver, the lurry, which was heavily laden with timber, collided with a Peel Green tramcar in Liverpool Road, with the result that the front and side windows of the car were broken, and other damage done. Passengers were standing on the car, both inside and out. Evidence was given on the defendant's behalf to the effect that the accident was due to the failure of the tramcar brakes to act.

In giving judgment, his Honour, Judge Parry, said there was nothing to show that the overloading of the car rendered the brakes less effective, and he did not suppose that the Salford Corporation would overload their cars to the danger of their passengers, though it was obvious they cared nothing for their passengers' comfort.

Judgment for the Corporation for the amount claimed.

Wigan Coal and Iron Co., Ltd.

In the Chancery Division recently, a petition was heard in which the above company obtained sanction to an alteration in its memorandum and articles of association, enabling it, among other things, to supply electricity for domestic purposes.

Charles Weetman *v.* Leicester Corporation.

In an action brought by Charles Weetman, cab proprietor, against the Leicester Corporation, in respect of damages sustained through a collision with one of the Corporation's electric cars, the plaintiff was awarded £3 8s. 6d., the Judge being of opinion that the motorman could have pulled up in time had he appreciated the position of affairs.

BUSINESS NOTES.

The "Oldbury" Conduit Fittings.—Messrs. The Oldbury Steel Conduits, Ltd., of Birchfield Lane, Oldbury, are introducing a new departure in conduit wiring fittings by which they claim to avoid stripping of cable insulation, and to make the drawing-in of wires easier and safer. In the new fittings, roller bearings are used for the wires when negotiating bends. In an elbow one roller is used, in a "T" piece, two, and in a cross-piece, four—one at each bend. Fig. 1 shows a cross-section of a roller elbow, while fig. 2 represents a sectional view of the complete

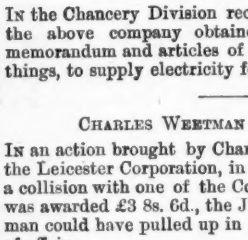


Fig. 1.

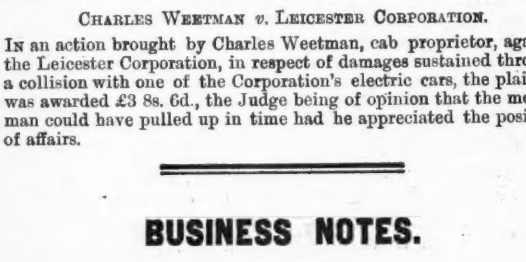


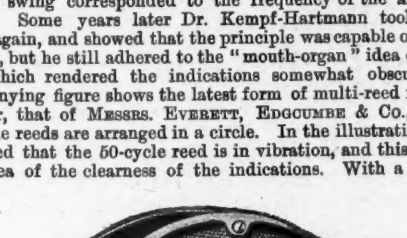
Fig. 3.

Fig. 2.

elbow and roller. Fig. 3 illustrates the elbow as erected, but with the inside exposed to view. It will be observed that the only point on which the cable can rest in passing round the bend is on the inner surface "A" of the roller, which begins to revolve immediately the cable moves over its surface, thus preventing rubbing action on the insulation. The fittings may be used as inspection fittings if desired, and they obviate the necessity for using bulky normal bends. By the insertion of a rubber ring beneath the covering plate they can be made watertight; it is claimed that fewer draw-in boxes need be used.

Electrical Works in Russia.—It is shown in the report of the Russian Allgemeine Electricity Co. for 1905 that the financial operations connected with the taking over of the factory of the Union Co. in Riga, were carried out during the year. As a consequence the share capital of the company, which formerly stood at £100,000, has been increased to £600,000, and 5 per cent. bonds amounting to £200,000 have also been issued. The works are booked at £258,000, and materials and semi-manufactures at £141,000, while the debtor account, which totalled £149,000 at the end of 1904, has now risen to £455,000. The accounts for 1905 show net profits of £22,080, as compared with £4,945 in the preceding year. It was possible to pay 4½ per cent. on the share capital of £100,000 in 1904, but the profits for 1905 have been devoted to the purpose of depreciation and the balance carried forward to the present year.

A New Frequency Indicator.—The suggestion was made years ago by Prof. Ayrton that if a sort of steel "mouth organ" were brought near the poles of an alternating current electromagnet, only that reed would be set in vibration whose natural time of swing corresponded to the frequency of the alternating current. Some years later Dr. Kempf-Hartmann took up the subject again, and showed that the principle was capable of extreme accuracy, but he still adhered to the "mouth-organ" idea of rows of reeds, which rendered the indications somewhat obscure. The accompanying figure shows the latest form of multi-reed frequency indicator, that of Messrs. Everett, Edgcumbe & Co., Ltd., in which the reeds are arranged in a circle. In the illustration it will be noticed that the 50-cycle reed is in vibration, and this will give some idea of the clearness of the indications. With a change of



The Everett, Edgcumbe Frequency Indicator.

frequency, the vibration passes evenly from one reed to the next, so that, from a short distance, the appearance is almost that of a pointer moving over a scale. Each reed, as a rule, corresponds to a difference of half a cycle, which enables the frequency to be accurately determined to within, say, one-fifth of a cycle. For special purposes, however, much smaller variations are possible, and the intervals at the working part of the scale can be made much smaller than at either end. The accuracy is quite independent of changes of voltage or wave form. In several instances these instruments have been adopted instead of tachometers, as being not only much more reliable, but also less expensive. Instead of being graduated in cycles per second, they are marked in revolutions per minute. Experience over prolonged periods has shown that, when properly designed, the reeds will maintain the same time of swing almost indefinitely, and within extremely close limits. The size of the instrument in its standard form is 8 in. across the base, and it is fitted in a cast-iron case finished in black and nickel or black and copper, as preferred.

High Tension Cables.—Referring to the recent article in the Electrical Review on the subject of high tension cables Messrs. The Land Und Seekabelwerke A.-G. write us as follows:—"At the Exhibition at Düsseldorf in 1902 we exhibited a three-phase cable for a working pressure of 50,000 volts, the copper conductor of which was insulated with three layers of india-rubber and some layers of impregnated fibre paper; the specific inductive capacity of the insulating material thus increasing from circumference to centre. The cable has also been successfully tested with a pressure of 135,000 volts without any damage to the insulation."

A Floating Exhibition.—The Floating Exhibition Syndicate, of 96, Victoria Street, S.W., has chartered the mail steamer *Cambroman* from the Dominion Co., and is now fitting her out for the exhibition of all kinds of British produce. Space will be set aside for each exhibitor, and provision is being made for the accommodation of a commercial agent for each exhibit or group of exhibits. The steamer will probably start from London early in the autumn for a year's cruise round the principal parts of the Empire, China, Japan, South America, and other countries which are important as markets for British products, her first port of call being Montreal. Over 40 ports will be visited altogether. The exhibition will be on view in London a week before the steamer sails.

Annual Outing.—The annual outing of the International Electric Co. took place on Saturday, the 11th inst. The party, numbering about 100, proceeded by train from Waterloo to Hampton Court. Thanks to the courtesy of the firm, a substantial luncheon at a riverside hotel was provided, at which the manager, Mr. Hermann Oppenheimer, presided. The weather being all that could be desired, a most enjoyable day was spent in the neighbourhood and on the river.

Electrical Exhibition.—A Health, Electrical and Gas Exhibition is to be held at Portsmouth from November 5th to 27th, 1906, under the management of Mr. R. R. Barnett, to whom, or to the secretary, Mr. V. D'O. Noble, 76, Pearl Buildings, Commercial Road, Portsmouth, communications should be addressed. Awards and certificates of merit will be given, and protection for new inventions will be sought from the Board of Trade.

Italy.—The following electrical concerns have been incorporated:—Società Elettrica Liguria Accidentale, Savona, capital 600,000 lire, to be raised to 2,000,000 lire, for production and distribution of electrical energy. Società Elettrica della Gera d'Adda, Milan, 250,000 lire, for the distribution of electricity in Romano, Lombardy. Società Italiana per l'Utilizzazione delle Forze Idrauliche, Milan, capital 80,000 lire, increasable to 300,000 lire, for the unification, purchase, or sale of hydro-electric schemes. Società Elettrica ed Elettrochimica del Caffaro, Milan, capital 4,000,000 lire, for the exploitation of the water power of the Caffaro Falls, and the manufacture of caustic soda and other electrolytic products. Società Italiana per Accumulatori Elettrici, Milan, capital 500,000 lire, raiseable successively to 1,500,000 and 3,000,000 lire, for the manufacture of electric accumulators of all systems and kindred articles; and the Co-operativa Telefonica Montagnese, Montagnana (Este), unlimited capital in 50 lire shares, duration 25 years, for the establishment and working of telephone systems in Montagnana and neighbouring districts.

Trade Announcements.—On account of the annual district holidays the works and offices of Messrs. Ferranti, Ltd., will be closed from this evening, August 24th, to Monday morning, September 3rd.

Mr. William J. Baldwin, Senr., consulting mechanical engineer, announces that he has removed his engineering offices to the fourth floor of the *World* Building, Park Row, New York City, U.S.A.

The Accumulatoren und Electricitatswerke Gesellschaft (W. A. Hoese & Co.), Berlin, is making arrangements to take up the manufacture of motor-cars.

The telephone number of Mr. Henry M. Sayers, 39, Victoria Street, Westminster, S.W., is "Victoria, 1,063."

Book Notices.—*The Marine Steam Turbine.* By J. W. Sothern. London: Whittaker & Co. Price 2s. 6d. net.—Compared with numerous works on the steam turbine which have passed through our hands during the past few years, this work stands in a category of its own. It makes no appeal to the designer as a mathematician, and presents the theory of the steam turbine in the form most likely to be of use to the marine engineer seeking a higher "ticket" from the Board of Trade. In other words, it belongs to the class of text-books popularly known as "practical." Among such it is entirely commendable, dealing as it does with the construction and operation of marine turbines, and the functions served by the various refinements introduced during manufacture. The book also has its value for the central station engineer, and chief engineers with turbines in their works might do far worse things than to insist that each shift engineer and mechanic on their staff should read this book. Exceedingly strong on the practical side of turbine construction, it is also strong on the practical side of turbine operation, and gives valuable hints to those engaged in overhauling. The illustrations are lucid, and several of the photographs of turbines for various vessels highly commendable.

"The Classification of Alternate Current Motors." By V. A. Fynn. London: The *Electrician* Printing and Publishing Co., Ltd. 3s. net.

"Steam Turbines, with an Appendix on Gas Turbines and the Future of Heat Engines." By Dr. A. Stodola. Second Edition of the Authorised Translation from the Second German Edition, with Mathematical Supplement and Aid, by Dr. L. C. Loewenstein. London: A. Constable & Co. New York: D. Van Nostrand Co. 21s. net.

"Fowler's Architect's and Builder's Handbook." Manchester: Scientific Publishing Co. 2s. 6d. net and 3s. 6d. net (leather).

"Elementary Manual of Applied Mechanics." By Andrew Jamieson. Seventh Edition. London: Chas. Griffin & Co., Ltd. 3s. 6d.

"Some Founders of the Chemical Industry." By J. Fenwick Allen. London: Sherratt & Hughes.

"Calendar of the Glasgow and West of Scotland Technical College for the Session 1906-7." Glasgow: The Secretary of the College.

"Polyphase Currents." By Alfred Still. London: Whittaker and Co. 6s. net.

"Report of the Proceedings at the Annual Meeting of the Industrial Freedom League held on July 12th, 1906." London: The League, 124, Palace Chambers, S.W.

"Report on Errors in Workmanship;" No. 25 of the Engineering Standards Committee. "Report on British Standard Systems for Limit Gauges (Running Fits);" No. 27 of the Engineering Standards Committee. London: Crosby Lockwood & Son, or the Committee. Price 10s. 6d. net and 2s. 6d. net, respectively.

Catalogues and Lists.—Messrs. W. T. Glover and Co., Ltd., Trafford Park, Manchester.—Leaflets giving details of standard cable end connectors and dividing boxes for various classes of cable and various conditions of use.

Messrs. Handley & Shanks, 40, Great Charles Street, Birmingham.—Leaflet giving particulars and prices of tantalum lamps, holophane shades and adapters.

The General Electric Co., Ltd., 71, Queen Victoria Street, E.C.—Leaflet No. 67, giving prices and particulars of Union steel conduit, watertight draw-in and junction boxes, the "Adaptor" fan, tumbler switches, cut-out boards, volt and ampere meters and bells, the prices of many of which have been reduced.

Also booklet No. O 1,114, dealing with motor-car and carriage lighting, and showing many types of fittings for head and side lights and interior lighting, omnibus and tramcar fittings, accumulators, direction indicators, and a variety of small accessories. All the fittings and lanterns are designed for use with the high-efficiency "Osmi" lamps.

The Sun Electrical Co., Ltd., 118 & 120, Charing Cross Road, W.C.—Leaflet relating to the Sun "Thermo-Blink" motorless flasher—a simple thermal device by means of which illuminated signs are flashed automatically and regularly without attention, bringing these signs within the means of the small shopkeeper. Box lanterns for use with the flasher are also supplied.

Messrs. Griffiths Bros. & Co., Macks Road, Bermondsey, London.—Leaflet concerning "Anti-sulphuric" enamel for protecting metal, wood, &c., against sulphuric and other acids and corrosive fumes.

Messrs. Davies Bros. & Co., Ltd., Crown Works, Wolverhampton.—Illustrated pamphlet describing iron roofs and buildings, constructional ironwork, galvanised corrugated sheets, fences, tanks, &c.

Messrs. R. H. Longbotham & Co., Ltd., Ings Foundry, Wakefield.—Leaflets describing electric haulage gear, hydraulic presses, &c.; also a number of second-hand steam alternators, engines of various types and sizes, winding and hauling engines, air compressors, locomotives, pumps and electric plant for sale.

Messrs. Baughan & Co., London Street, Reading.—A well illustrated brochure showing examples of installations of dynamos, motors, batteries, electric lighting, bells, telephones, &c.

Messrs. Cutting Bros., Ltd., Park Works, Stamford.—16 pp. pamphlet, giving specification and tabulated details and prices of their motors and dynamos. Dimensional particulars also appear, and the half-tone illustrations include a view in the firm's works.

Messrs. Johnson & Phillips, Ltd., Charlton.—Small booklet describing and well illustrating electric cable-making machinery as manufactured by them. These include sheathing, paper lapping, and stranding machines, drying and impregnating pans, lead cable covering press, rubber covering and mechanical rubber-sheeting machines, &c.; a list of cable gear equipments recently supplied is given.

Mr. G. Feldt, 50 and 51, Fore Street, London, E.C.—Leaflets describing the qualities and uses of "Tinol," the patent soldering paste described in our last issue, with prices, &c.

Messrs. Turner & Burger, Audrey House, Ely Place, E.C.—Illustrated price-list of electrical accessories and fittings, including lamp-holders, switches, wall plugs, cut-outs, pendants, reflectors, bell pushes &c., in great variety.

Bankruptcy Proceedings.—The public examination was held on Tuesday before Mr. Registrar Linklater at the London Bankruptcy Court of Frederick William Atterbury, electrical engineer, 89, Clarendon Road, Kensington. The statement of affairs showed liabilities £454 13s. 3d., and assets £5 11s. 6d. Questioned by Mr. E. L. Hough, Senior Official Receiver, the debtor stated that he, in or about 1895, with a small amount of capital, commenced business as an electrical engineer, with an office at 22, Finsbury Market. Since February, 1905, he had not had any business premises, and had only executed jobbing work. Witness attributed his failure to liability for interest on loans raised on property which he purchased and mortgaged as the nominee of another person, and to losses in trading, principally under a contract for the installation of electric light entered into in 1899, when he was carrying on business at 5, Wilson Street, E.C. The examination was concluded.

Joseph T. Firbank, Ltd., Contractors.—The first statutory meetings of creditors and shareholders were held on the 16th inst. The company had been engaged on, among others, several large railway contracts, including the construction of the Park Royal generating station for the Great Western Railway Co. The estimated assets were £61,857; unsecured liabilities were stated at £14,756; the debenture holders claimed £120,000, and the total deficiency to the creditors was estimated at £81,738. The liquidation is in the hands of the Official Receiver.

Lazarus Blumenthal, Electrical Merchant, 78, Queen Victoria Street, E.C.—The receiving order in this case was made upon the petition of Messrs. Krupka & Jacoby, of Watling Street. At the first meeting of creditors a statement of affairs was lodged, showing liabilities £2,477 4s. 2d., and assets nil. The debtor stated that he came to England from Germany in March, 1896, with an invention for an improved telephonic apparatus, and possessing between £500 and £1,000 of his own. In July, 1897, he registered a limited syndicate, which acquired from him the licence to work the patents, the sale consideration being £15,000 in fully-paid shares. The debtor was appointed managing director of the syndicate, but it became moribund in 1902. He attributed his failure to losses in connection with the invention, and want of capital. No proposal was submitted, and the Official Receiver said that the matter would remain in his hands to be dealt with in bankruptcy.—*City Press.*

Mr. John Fell, engineer and contractor, late of Leamington, and now carrying on business at Victoria Street, Westminster.—At the London Bankruptcy Court, on the 21st inst., an adjourned examination was held; debtor applied to pass his examination upon accounts showing unsecured debts £3,932, and assets £2,914. Since 1896 he had acted as engineer and valuer for the construction of various tramways, &c., including the Gloucester Light Railways, Mansfield and District Light Railways, Weston, Clevedon and Portishead Light Railway, Barrow-in-Furness Tramway, Nottingham and Derby Tramways, and the Potteries District Tramway.

He attributes his insolvency to pressure by creditors, and to losses on a contract for the construction of a tramway in Staffordshire several years ago, on the projected construction of a bridge across the Tyne at South Shields, and on other abortive schemes. Debtor had submitted a scheme to the creditors for the payment of 7s. 6d. in the pound on the debts, he to vest his estate in a trustee and to pay to him one-half of his net earnings or income for the period of three years. The scheme was accepted, and the examination closed.

Liquidations, Dissolutions, &c. — N.S. Electric Storage Co., Ltd.—Notice is given in the *London Gazette* of August 17th, that at extraordinary general meetings of the above company on July 26th and August 13th, it was resolved and confirmed that the company be wound up voluntarily, and that Mr. G. Pepper, of Pier Chambers, Chatham, be appointed liquidator.

Poole and District Electric Traction Co., Ltd. (in liquidation).—Notice is given in the *London Gazette* that an extraordinary general meeting of the above company will be held at Donington House, Norfolk Street, W.C., on September 19th, when the liquidators will present a report of the manner in which the winding-up has been conducted.

Electrical Corporation, Ltd.—The petition of O. C. Hawkes, Ltd., for compulsory liquidation, was allowed to stand till next sittings, the corporation having passed a resolution for voluntary winding up. Mr. E. Wilding, Dashwood House, New Broad Street, has been appointed the liquidator.

International Electric Traction and Power Syndicate, Ltd.—The creditors of this company, which is being voluntarily wound up, are required to send in their claims to John Morris, 33, Brazennose Street, Manchester, before September 13th.

Prices Advance.—Austro-Hungarian electrical firms have decided to increase the advance of 10 per cent. on list prices of electrical goods current since January 1st, to 15 per cent. The cause is the steady increase in the price of all raw materials. German and Swiss firms have made similar increases since May.

LIGHTING and POWER NOTES.

Ashton-in-Makerfield.—The U.D.C. has applied to the B. of T. for another year's extension of the E.L. order.

Australia.—Tamworth, N.S.W.—A scheme for supplying electricity for private lighting was submitted by the borough electrician recently, and agreed upon by the Council. The scheme provides for the installation of two dynamos and a small storage battery. The charges for energy will be 6d. per unit for lighting and 4d. for power. The Council will do the interior wiring for house-owners, on quarterly instalments extending over a period of five years. There will be an initial expenditure of £4,000 on the plant, and £1,000 on interior wiring.

Melbourne.—To meet the growing demands for energy, the Electric Supply Committee of the C.C. has recommended the expenditure, immediately, of £105,000. The value of the machinery to be scrapped amounts to £79,550, which it is proposed to sell for £15,000. On the conversion of the outside plant for public and private supply, it is proposed to spend £42,710; for the conversion of the street-lighting plant at the station, including the alternating-current private supply plant, £15,530; alterations to engine-room buildings, £1,455; extensions of boiler-house plant, £6,900; other building improvements, £17,175; contingencies, £2,000; and direct-current supply, £19,800. Private supply in the central portion of the city has been changed to the D.C. system, supplied by underground mains, and the public lighting in the same area is to be changed to the same system. On the completion of the latter the whole of the electric supply within the underground mains area will be generated from the one plant. For public lighting 545 arcs and 870 incandescent lamps are to be provided. Provision is made for installing new 500-KW., 750-KW. and 150-KW. generators, with steam turbines. Four old boilers are to be replaced by two new boilers, with an overhead coal bunker of 2,200 tons capacity. For the direct-current supply a new 750-KW. generator is proposed.—*Australian Mining Standard.*

Barrow-in-Furness.—The income of the Corporation electricity undertaking from lighting during the past year's working was £13,311, and from energy supplied for traction purposes, £2,515. The working expenditure was £6,532. The number of lamps connected amounted to 56,493, and the number of units sold was 917,925, an increase of 80,471 over the previous year. The net profit for the year was £840, against £1,199 in 1905. This reduction is accounted for by one of the largest consumers installing a private plant. An extension to the works is almost completed, and new plant of 500 KW. capacity is to be installed.

Bideford.—The T.C. has deferred consideration of notices received from Messrs. Foote & Milne, Ltd., the Mutual Electricity Supply Co., and Messrs. Crompton & Co., of intention to obtain a prov. order for E.L. in the district. The Council has received repeated notifications of a similar character, and has invariably replied that "it hoped to apply for an order itself."

Cambrian Collieries.—The Cambrian Collieries, Ltd., have issued a circular to their shareholders dealing with the present position of their property, and it is stated that it has been decided to work the whole of the engines above and below the ground, with the exception of the winding and fan engines, by electric power. A contract has been entered into with Messrs. Siemens Bros. for the requisite plant, and it is hoped that the installation will be completed early in 1907.

Canada.—Toronto.—A conference was held on the 8th inst. between the civic authorities and the Hydro-Electric Commission of Ontario, regarding the amount of electric energy to be taken by the city from the Commission. Some time ago the Commission asked the City Council to give some approximate idea. The Mayor, basing his report on the investigations of the city engineer, mentioned that 30,000 H.P. would suffice for a start. This estimate is below that prepared by the Hydro-Electric Commission in its report, in which it is computed that Toronto would take about 55,000 H.P.

Ottawa.—Representatives of the City Council and the Ottawa Electric Co. held a conference on the 8th inst. to endeavour to come to some understanding in regard to the operation of the electric plant taken over by the city from the Consumers Co. Two propositions were made by the Ottawa Electric Co.: (1) was that it should be allowed to run the plant until such time as a dividend of 6 per cent. is earned; and (2) that the company should assume charge of the Corporation's plant and drop all litigation which has been instituted or is contemplated against the city. The mayor has promised to give the second offer consideration.

Carnarvon.—The T.C. has decided to promote a private Bill in order to legalise the agreement with the National Electric Construction Co. for the establishment of an electricity supply. This is in consequence of the recent decision in the case of Sudbury T.C. *v.* The Empire E.L. Co.

China.—The British Consul at Ningpo reports that a project is on foot for the installation of electric light there. At present it is doubtful whether a concession will be obtained by a British firm, or whether the work will be undertaken by the Japanese, who are interested in a new cotton mill.

Continental Notes.—Italy.—A Commission (says *l'Industrie Electrique*) nominated by the Italian Government has just estimated the total available water-power at 3,750,000 H.P. There are in the 58 Italian provinces 24,486 waterfalls, which have together a mean power of 2,000,000 H.P.; of this amount 38 per cent. is situated in the north, 26 per cent. in the centre, and 30 per cent. in the south, the small remainder occurring mainly in Sicily. In addition to these existing falls, the great rivers can furnish 575,000 H.P., of which 130,000 is already taken up; the Tiber alone can supply 375,000 H.P., and already gives 75,000 H.P. The annual cost of imported coal is at present 150,000,000 fr.

The authorities of the Modena province have granted a concession for a plant to be put down on the River Mariono, at Vignola, for electrical power purposes.

Turkey.—A French company has received a concession for the installation of electric light and the construction of an electric tramway at Philippopolis.

Germany.—That lack of British industrial statistics, to which Parliamentary attention was recently drawn, is especially felt in comparison with the ample data published by certain foreign Government and municipal departments. The details of the development of the electrical industry in Berlin just published are, for example, especially ample. The total consumption of electrical energy there is:—Lighting, 42,841 KW., and power, 52,644 KW. There are consumers to the number of 14,701; and the motors supplied total 15,403, or the equivalent of 55,666 H.P. The glow and Nernst lamps in use number 619,625, and are lamps 26,612, of which only 615 are allotted to public lighting. On June 30th, 1905, there were 12,549 motors connected, equal to 39,921 H.P., allocated to the driving of the following appliances:—Ventilating fans, to the number of 1,868, of a capacity of 601 H.P.; presses, 1,730, 5,005 H.P.; metal-working machinery, 1,775, 7,351 H.P.; lifts, 1,698, 9,704 H.P.; wood working machinery, 1,241, 4,751 H.P.; slaughterers' and butchers' machinery, 678, 2,394 H.P.; sharpening and polishing machines, 376, 1,390 H.P.; paper factories plant, 369, 1,149 H.P.; pumps, 252, 906 H.P.; sewing machines, 222, 209 H.P.; cloth-cutting machines, 194, 140 H.P.; washing machines, 230, 672 H.P.; spinning machinery, 96, 274 H.P.; leather dressing, 111, 417 H.P.; galvano-plastic appliances, 75, 239 H.P.; dynamo driving, 76, 809 H.P.; coffee-grinding and roasting machines, 78, 153 H.P.; and sundry, 1,473, 3,565 H.P.—*Revue des Eclairages.*

The extent to which water-power is made use of in Germany to generate electricity is shown by the fact that of a total of 1,178 electrical works of a total capacity of 517,494 KW., 475 make whole or partial use of water-power. In detail, 125 works of a capacity of 15,582 KW. employ water-power alone; 219 of 61,692 KW., water (and steam as reserve); and 18 of 1,572 KW., water and gas; the rest are of small size.

The Lech Electrical Works Co., which supplies Augsburg with electric light, has been authorised to extend its establishment by the erection of a hydro-electric power station below its existing works, which will represent an addition of 3,500 H.P. to its present capacity.

Spain.—The Société des Forces Motrices du Sud-Est de la France has made an offer to the Mayor of Barcelona to supply motive power from waterfalls in the neighbourhood of Puycerda, in territory belonging to France and Spain. The price of this energy delivered in Barcelona will range between 5 and 7 centimes per kilowatt-hour. The power will be used to lift sea water to flush the city sewers and for the provision of public lighting.

Farnworth.—The Lancashire Electric Power Co. is now supplying energy to Messrs. Thomas Nuttall & Son's Lakefield spinning and weaving mills, Brookhouse, which will supplement the existing steam power.

Hastings.—The T.C. has received from the L.G.B. sanction for a loan of £8,386 for electricity purposes. The Council applied for £8,761, and the sum deducted is the debt outstanding on the switchboard which is to be superseded.

Hindley.—The U.D.C. has decided to obtain information as to the best means of carrying out the E.L. order, whether by working it, transferring it to a company or some neighbouring local authority, or obtaining a supply of energy in bulk. The Wigan T.C. has been asked if it is able to supply energy in bulk, and upon what terms.

India.—Calcutta.—Our Indian correspondent says that at a recent meeting of the Calcutta Corporation it was proposed (1) That the Electricity Supply Corporation should lower their rates from 8 annas per unit for lighting, and 4 annas for power, to a uniform flat rate of 3 annas per unit all round; (2) That, if the supply company would not consent to this proposal, the Corporation itself should apply for a licence under Section 4 of the Indian Electricity Act. The force of public opinion, he says, will probably cause a considerable reduction in the company's charges in the near future.

Lucknow.—After duly accepting the tenders of three firms for the complete electric lighting of Lucknow Cantonments, the Military Works Authorities have now decided that the expense is too great, and have, for the present, abandoned the idea. This is a serious grievance to *bona fide* tenderers, who are put to considerable expense in preparing plans and estimates. The same thing happened at Mian Mir; tenders were duly accepted, and after a time the successful firms were informed that the deal was "off." If this vacillating policy is continued, tenderers will fight shy of military works contracts in future.

Calcutta Port Commissioners.—A new electric plant has just been laid down at Kidderpore, including a modern generating station equipped by Messrs. Jessop & Co.; about 20 motors varying from 25 to 4 H.P. for driving tools in workshops; and six overhead electric cranes—two 15-ton, one 10-ton, two 5-ton and one 3-ton—supplied by Messrs. F. & C. Osler, who are also supplying 150 flame arc lamps for dockyard lighting.

Cawnpore.—The Cawnpore Electric Supply Co. will shortly be in a position to supply energy for traction and lighting purposes. A considerable motor load is anticipated in this busy manufacturing centre.

Train Lighting.—Messrs. Stone & Co. have arranged with the Madras Railway Co. for a trial of their system of electric lighting for trains. The experiments will be conducted for a period of six months, and for the first three months the supervision and control will be entirely in the hands of the Stone Co. During the second three months the trials will be run by the Madras Railway, under the general supervision of the contractors.—*Indian Engineering.*

Lahore.—The electrical installation at Lahore has been taken over by the P. W. D. (Punjab).

London.—Hammersmith.—The L.G.B. district auditor has disallowed the sum of £799 on the Guardians' electric lighting account, and surcharged four of the Guardians with various amounts. He has disallowed the sum named because the Guardians have to that extent over-expended the amount sanctioned. The Guardians have decided to apply for an order authorising the borrowing of £1,000 on account of E.L. contract extras. The Hammersmith and Shepherd's Bush Ratepayers' Association has sent a letter of protest to the Board against the sanctioning of the loans.

L.C.C.—The L.C.C. has addressed a letter to the Metropolitan City and Borough Councils on the subject of the constant disturbance of London streets by companies and others having the legal power to break them up, inviting the support of the Councils in bringing about a remedy. The Highways Committee is of opinion that great advantages would result if arrangements could be made for works carried out by different authorities having powers to break up streets, to be, as far as possible, executed simultaneously at certain times of the year.

Londonderry.—At a special meeting of the Corporation held on the 16th inst., a letter was read from Messrs. J. G. White & Co., London, regarding a proposal to purchase the electrical undertaking, which has cost the city over £60,000. The company also offered to promote an electric tramway scheme for the district. By ten votes to nine the matter was referred to a committee.

Margate.—The T.C. has decided to install an E.L. plant at the Wingham Waterworks.

Selby.—The U.D.C. has decided to apply to the B. of T. for a prov. order for E.L.

Saffron Walden.—The T.C. has decided to consent to the revocation of the E.L. Order, 1904, and to consent to a new order being applied for by Mr. Mark Parker, or by a company to be formed by that gentleman.

Shrewsbury.—The T.C. has given lighting consumers the option of a flat rate of 5d. per unit.

South Africa.—Rhodesia.—The Odzani River power scheme was recently inaugurated in the Penhalonga district. Electrical energy will be used to drive the batteries of the Penhalonga Proprietary mines and the whole of the machinery on the Rejende. The power transmission plant was supplied by Messrs. Hubert Davies & Spain, and the electrical portion by the Electric Construction Co. The construction work was under the supervision of Mr. Harold Wragg, the P.P. Mines electrician.

Johannesburg.—In accordance with the policy outlined by the chairman of the Rand Central Electric Works at the annual meeting in London last May, the directors have decided to increase the present plant by new units of 2,500 KW. each. Turbo-generators will be installed. The total cost of the scheme is estimated at £475,000.

South America.—The Argentine.—The prospectus of the Compania Anglo-Argentina de Electricidad has been issued with a registered capital of $2,000,000 m/n. The company has been formed to acquire the following electric light stations:—Concordia, Concepcion del Uruguay, Gualeguay, Tandil and Chascomus. These have been acquired for $790,000. Mr. H. B. Buxton is manager, and W. G. Cassini is engineer.

Sowerby (Thirsk).—The P.C. has accepted the offer of the local E.L. company to light the public lamps (40 C.P.) for 1,380 hours at 28s. per lamp per annum.

Taunton.—The E.L. Committee has received a letter from the Taunton Electric Traction Co. asking the T.C. to assist the company in connection with the proposed extension to Rowbarton by granting a reduction in the price now charged for electrical energy supplied to the cars. Under present agreement the company pays for the first 60,000 units per annum at the rate of 2d. per unit, next 60,000 units per annum 1½d., next 80,000 units 1¼d., balance at 1d. The T.C. has agreed to the recommendation of its Committee to amend the charge as follows:—First 40,000 units per annum at the rate of 2d.; next 40,000, 1½d.; next 80,000, 1¼d.; balance at 1d., with a minimum charge per annum of £500. The company has accepted the terms offered.

The Highlands.—The *Financial Times* states that a syndicate of London and Glasgow financiers will, in the next session of Parliament, apply for powers to utilise the waters of Loch Awe, with a view to generating electricity. The syndicate proposes to lay down electric furnaces for the production of steel.

Train Lighting.—The Great Northern Railway has completed a new train lighted throughout by electricity, clusters of electric lights being fitted in the roof, whilst in the dining car table lamps with artistic shades are provided.

Walsall.—The T.C. has received from the L.G.B. sanction to a loan of £12,694 for electricity purposes. The Council applied for £13,000, and the balance deducted is in respect of a sum needed for the purchase of land from another Corporation Committee, which the L.G.B. refused to sanction.

West Ham.—The Corporation has commenced cable-laying for the electricity supply to Silvertown, which it is hoped will be available about October. In view of the fact that there are in this district some of the largest factories in London, it would be worth the while of contracting and manufacturing companies to canvass it vigorously. The system will be 200 volts, two-phase, 50 cycles. Supply rates are low; 1d. per unit, less discounts up to 15 per cent., and specially low rates for long-hour demand. The Corporation has already secured contracts for several million units per annum, but that does not nearly represent the extent of the possible business. In most cases energy for lighting can be supplied at the same rates as power to factories using energy for motive power. Mr. A. Hugh Seabrook, engineer and manager to the Electricity Supply Department, says that it is no use sending any but experienced engineers to interview factory managers and proprietors. Every assistance and information will be rendered from his office.

Wigan.—The Douglas Bank Collieries, Wigan, have been electrified.

Willington.—The Durham County Electric Power Distribution Co. has informed the U.D.C. that arrangements have been made whereby it will be enabled to give a general supply of energy to the district about March 1st next. The company has asked the Council to consent to the use of overhead mains, and thereby allow of energy being supplied at about half the usual rates.

Yardley.—The Tramways and E.L. Committee having recommended that the Council's undertaking, authorised by the Rural District E.L. orders 1904 and 1906, should be transferred to the Birmingham Corporation, or to the Shropshire, Worcestershire and Staffordshire E.P. Co., the Committee was asked to prepare a report as to the terms offered by the two bodies, for presentation to the Council in committee.

ELECTRIC LIGHTING AND TRAMWAYS AT FREMANTLE, W.A.

On October 30th of last year the first two sections of the Fremantle Municipal tramways were put into operation, together with the city lighting sections, the lighting of the city and district being also a municipal undertaking in conjunction with the tramways.

Fremantle proper has a population of about 23,000, and the suburb of East Fremantle, with a population of 4,000, is also included in the undertaking, having furnished one-seventh of the capital.

For the student of municipal ownership and control, Fremantle offers a good example of what may be accomplished in that direction. A number of firms were applying for a concession to build and operate the tramways and lighting system, in fact, one company had the concession, but for some unknown reason allowed it to lapse; the city then started to gather information on a municipal scheme of control. At that time cabs were the only means of transit, and these, in common with the gas lighting service, were equally unsatisfactory. A private Act was passed through the State Parliament, which brought into power a board of five members called the Fremantle Municipal Tramways and Electric Lighting Board, the members being elected on a separate franchise, as follows :—One each in Fremantle and East Fremantle by freehold property owners, also one each in both municipalities by occupiers of property, making four in number; the Mayor of Fremantle is, *ex officio*, the fifth member. The control of the tramways and lighting is therefore handed to a board constituted solely for their management. This is the first and only municipal tramway in Australia, the others being either State owned, as in New South Wales, or privately owned, as in the remainder of the States. Municipal lighting, on the other hand, is quite customary in Australia. The well-known firm of Noyes Bros. secured the contract for the undertaking on a commission basis for which they were to find the capital, design, buy the necessary material, supervise and control the construction on behalf of the Tramway Board. The necessary powers for borrowing up to £100,000 by the municipalities on debenture stock were incorporated in the private Act before mentioned. The work is now successfully completed, although the contract time does not elapse for two more months, and some sections have been working, as already stated, since October last.

The power house is a substantial brick building situated at the South Mole on the edge of the harbour, and alongside the railway. At one end of the building is located a small iron structure in which a battery is housed. The main building is divided into an engine room 87 ft. long × 34 ft. wide and a boiler room 87 ft. long × 45 ft. wide.

In the boiler room are installed four boilers erected in pairs, and there is room for two more boilers of the same capacity. The boilers are of the Babcock & Wilcox type, each having a heating surface of 1,426 sq. ft., and grate area of 28 sq. ft. They are designed for 160 lb. working pressure, and up to 150° F. superheat. The two feed pumps installed are of the Worthington Duplex type, having a steam cylinder 6 in. diameter, water cylinder 3½ in. diameter with 6 in. stroke, and are of the usual standard brass fitted pattern.

A Cuttmann water softener having a capacity of 300 gals. per hour, is located in the boiler room. Exhaust steam from the feed pump is utilised in the water softener for precipitating the impurities, soda ash being used as the reducing agent; this treatment was essential on account of the very hard nature of the local water.

In the flue is located a Green economiser, in two sections of 96 tubes each; the scrapers are electrically driven. The chimney is of brick, 109 ft. 6 in. high and 5 ft. 9 in. inside diameter.

A condenser of the Worthington surface type is installed, with a cooling surface of 1,400 sq. ft.; an air-pump by the same maker, is of the vertical three-throw single-acting type, driven by a 500-volt Westinghouse shunt-wound variable speed motor, and a similar motor operates a centrifugal circulating pump. The piping for the inlet and discharge of the circulating pump is carried in a brick tunnel under the building, directly to the sea. This latter construction permits of the suction pipes being readily inspected, and also eliminated a long discharge pipe, besides allowing for a handy drain from the boiler room.

In the engine room are installed four generators, two being D.C. machines for the tramways and two A.C. machines for lighting, each direct connected to high speed engines. The D.C. generators are each of 150 KW. giving 550 volts at 430 r.p.m. compound wound; while the A.C. generators are each 150 KW., 2,200 volts, two-phase, 50 cycles, with a speed of 428 r.p.m.; the exciters for the latter are mounted directly on an extension of the main bedplate. The A.C. generators have revolving fields and stationary armatures, and were manufactured by the British Westinghouse Co.

The four engines are of the Belliss & Morcom high speed vertical compound type, taking steam at 150 lb. pressure, with 100° F. superheat, and running with a 24-in. vacuum; they are guaranteed to give 265 B.H.P., with a consumption not exceeding 22 lb. steam per KW. at full load, and 23·4 lb. at half load under the same conditions.

The switchboards are situated at one side of the engine room. The D.C. board consists altogether of five marble panels, arranged as follows :—Two generator panels fitted with circuit-breakers and the usual instruments; one battery panel with a circuit-breaker and differential ammeter and voltmeter, &c.; two feeder panels which have been arranged for supplying two feeders on each panel, with the usual meters and switches. The board is also fitted with a main voltmeter, ammeter, and Thomson watt-hour-meter.

The A.C. board is entirely separate from the D.C. board, and consists of six panels, also of marble; these include two generator panels, with oil break switches, ammeters, and recording and integrating wattmeters, with the usual ground detector. In front of each panel are pedestals on which are mounted the field switches and handles which control the field resistances. Three of the feeder panels are similar with the exception of Stillwell regulators; each feeder panel is arranged with two single-phase double throw oil break switches and an ammeter in each phase. There are four Stillwell regulators on the board for controlling the same number of single-phase feeder circuits. An arc panel is fitted up for one series A.C. arc circuit with a double-throw oil switch and ammeter; there are also three plug switches for short-circuiting or opening the secondary of the balanced regulating arc transformer, which is located in the basement. Both of the boards were supplied by the British Westinghouse Co.

The battery consists of 265 cells of the German Tudor type; it has a capacity of 295 amperes at the one hour rating and a charging rate of 144 amperes.

A Westinghouse automatic reversible booster set has been installed for charging purposes. The booster is of the differential multipolar type, having a capacity of 150 amperes at 150 volts. The exciter furnishes the current for the shunt fields of the booster and carries the main current in its series field winding, while its shunt is separately excited.

The tramways consist of 7 miles of single track lines, built to 3 ft. 6 in. gauge, the latter being the standard for Western Australia.

There are four different routes, with a loop in the central part of the city. The construction is single track throughout, with passing stations suitably placed.

The rails weigh 92 lb. per yard, and are of the grooved girder type, 6½ in. deep, with 6½-in. base; on curves a 95-lb. section has been adopted. The rails and special work were supplied by the Lorain Steel Co.

In the construction of the permanent way on macadamised roads, the street was excavated to a depth of 15 in., and Jarrah sleepers (each 6 ft. 6 in. × 9 in. × 4½ in.) were spaced 2 ft. 6 in. apart, resting on a 4-in. bed of hard ballast.

Each rail joint is bonded with two No. 0000 B. & S. Chicago bonds, and every other rail is cross bonded with

No. 00 B. & S. tinned cross bonds applied to the rails by the plastic alloy method with bolted heads.

After the rails, sleepers, bonds, &c., had been placed in position and the capstone ballast filled in to a couple of inches above the rails, the whole was rolled by an 18-ton roller, and afterwards packed under the head and guard of rails. The top was then sprinkled with tar and covered with 2 in. of tarred ironites (broken slag) and a further layer of tarred screenings, and again rolled with the steam roller. The result has been a remarkably good road, at a minimum cost.

Fig. 1.—Mr. A. Mitchell, Engineer and Manager, Fremantle Municipal Electric Lighting and Tramways.

Fig. 2.—Exterior of Power Station.

Part of the track was paved with wood blocks, 6 in. deep, resting on a concrete bed 8 in. thick. For putting down the rails it was necessary to chip a groove in the old concrete to allow for a fresh bed. The rails were anchored at every joint to an inverted piece of old tram rail, bolted up and buried in the concrete. On curves and special work the anchors took the form of sleepers of the standard type, buried in the bed with the rail secured to them by screws.

For carrying the overhead work in the central part of the city, about a mile of steel span and anchor poles were put in. These were supplied by the Mannesmann Co. Some of the tramway poles carry wires and arc lamps for the lighting, and where this occurs the poles are slightly larger, with the necessary arms for carrying the cables and lamps.

The wooden span and anchor poles are of West Australian Jarrah, 29 ft. long, with 10 in. diameter base and 7 in. diameter top, for the span poles, and for anchor poles 29 ft. long, with 12-in. and 9-in. diameters respectively. An ornamental cast-iron cap is placed on the top, which protects the pole from splitting. All the poles are planted a depth of 6 ft., concrete being used with the steel an wooden anchor poles.

Fig. 3.—Power Station: Generators, Switchgear, &c.

The trolley wire is No. 000 B. & S. gauge, circular section, and double throughout.

To protect the P.O. telegraph and telephone wires, guard

wires consisting of two No. 10 B. & S. galvanised wires, carried about 18 in. above the trolley wire, and separated from each other by about 2 ft., are fixed. These are insulated from ground by small button insulators being interposed between main guard wires and the poles.

Fig. 4.—Car-Shed, and Tunnel Through which Cables Pass to Power Station.

The tramway feeders are four in number, and are carried underground from the power house to the car-shed, where they are brought up the poles and carried to their various feeding points by aerial cables.

The car-shed is a substantial two story brick building: the ground floor is used for the storage of cars, five tracks being provided, also for rooms for motormen and conductors, a store, receiving office and machine shop. The first floor contains the board's, manager's and general offices.

The rolling stock consists of 14 Brill combination type cars, each seating 36 passengers; these differ from the standard California type, inasmuch as a partition between the motorman's platform and the open compartment is placed so that there is no passenger seat on the motorman's platform. The cars are mounted on trucks with a 6 ft. 6 in. wheel base.

Each car is equipped with two motors and controllers, also the Newell magnetic brakes, all being supplied by the British Westinghouse Co. These cars are without doubt the finest in Australia, as the design is extremely suitable for the climate. The weather, even in the winter, is not cold, and in the summer the cars should be as open as possible, though protection from the dust is required.

A sprinkler car of the standard Brill pattern, with double-head sprinklers at both ends, and with a capacity of 2,500 gallons, is provided.

The lighting system was designed to supply private and public lighting and power for the general public use, harbour trust, railway department, and private supply.

The public lighting consists of 40 2,000-nom. c.p. Westinghouse a.c. series arc lamps for the main business streets, controlled from the power house by a transformer regulator. There are also 100 and 50 c.p. a.c. Nernst lamps, run in parallel on a 220-volt l.t. circuit, which latter is fed from the main 2,200-volt h.t. circuits from the power house. The latter circuits feed both the l.t. public and private feeders, through large transformers located in the various city sections. From each one of these transformers separate 220-volt l.t. mains radiate: the public supply mains will be controlled from the power house by a master switch which will open or close electrically operated switches at each transformer, for the above mentioned public supply mains. Although the system is a two-phase one, the lighting is all single-phase.

The power supply is either 220 volts two or single-phase, for motors not exceeding 5 h.p.; the supply for the Harbour Trust will be three-phase, cranes, hoists and capstans being used. The current will be delivered by two-phase h.t. mains to the transformers, and there reduced to 440 volts three-phase by the Scott method of connection.

The lighting for the Trust will, however, be carried out on the 220-volt single-phase scheme.

The rate of charges for light varies from 7d. to 4½d. per unit, according to the amount used per month, and for power similar prices per unit for about half the consumption specified for lighting. A discount of 1d. per unit is allowed, and meter rents are charged.

The fares on the tramways are 3d. from any part of the city to the termini of any line: on what is called the city loop, from the Town Hall on High Street, and the City Markets on South Terrace, to termini in business parts of the city, 1d. Transfers are issued at all connecting lines.

THE BURTON AND ASHBY LIGHT RAILWAY.

Although it has for some time been the practice of American Railroads to promote and work electric trolley tramways in districts where an active competitor might injure their traffic, we believe the Midland Railway Co. can claim the distinction of being the first English railway to construct and work such a line, viz., the Burton and Ashby Light Railway, under similar circumstances.

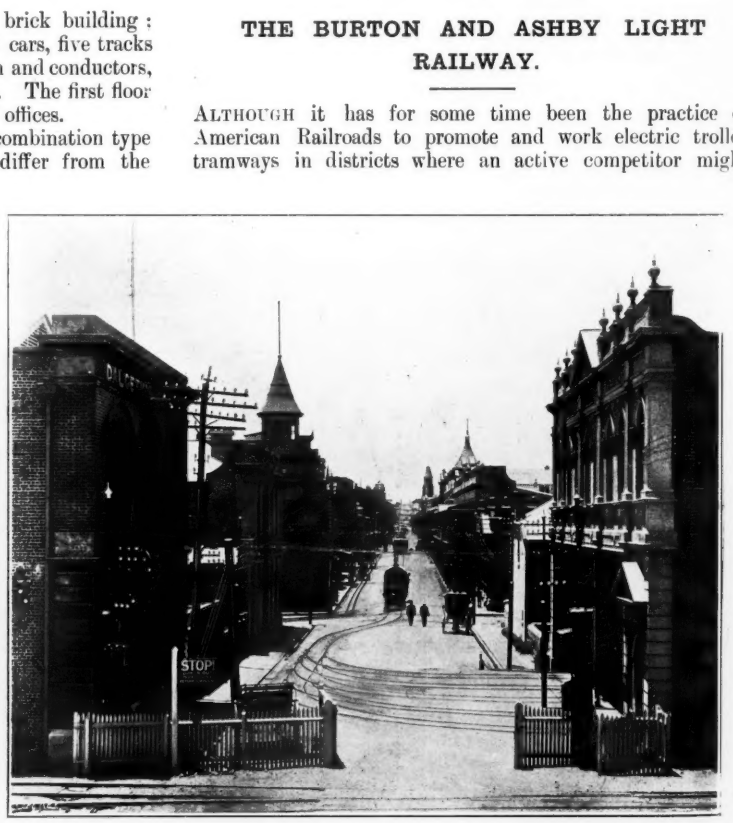


Fig. 5.—High Street, Fremantle, showing Car-Shed on Right.

A somewhat similar scheme had been under consideration for some time previously by a local syndicate, who were, however, successfully opposed by the Railway Co., which itself undertook the scheme.

The line is some 11½ miles in length, including 1¼ miles in the town of Burton, which were constructed and leased by the Corporation on certain terms.

As regards the remainder of the line, the local authorities through whose areas it passes, can acquire the undertaking, but must re-lease it to the vendors at terms mutually agreed on or fixed by arbitration.

The routes operated by the company's cars, are from the railway station at Burton to Ashby Station *via* Ashby Road, Stanhope Bretby, Newhall, Swadlincote, and Woodville, also a branch to Gresley Station: they pass through somewhat populous villages engaged in the mining and pottery industries, and are, on the whole, of a hilly nature, containing several sharp gradients.

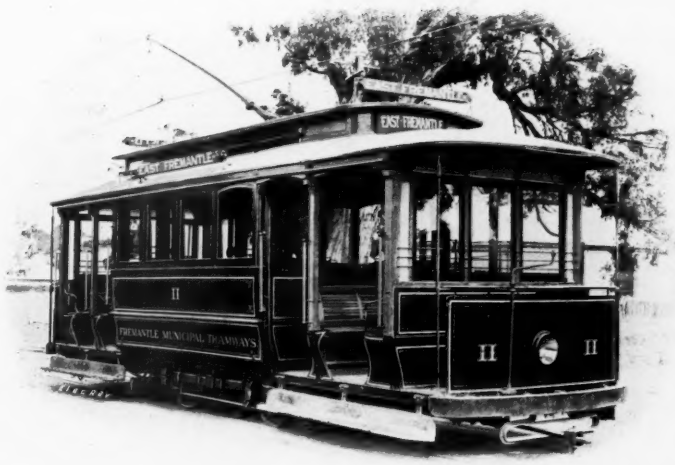


Fig. 6.—A Standard Fremantle Car.

The track follows the public roads, with the exception of a length of about three-quarters of a mile, which, to save a long detour and some awkward curves, was constructed as a tramroad across the fields.

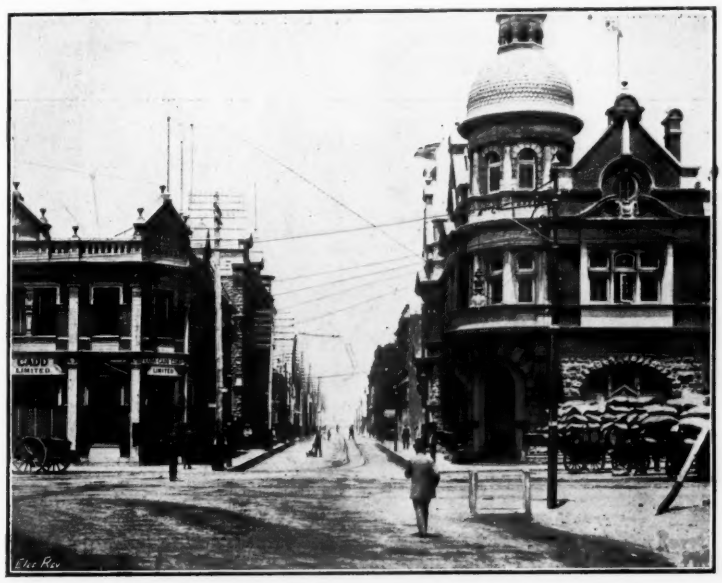


Fig. 7.—Fremantle: A Main Tramway Route.

At Swadlincote a girder bridge, some 110 yards long, with approaches, has been provided to carry the tramway over the company's railway, this being necessary on account of the incessant shunting operations which take place at that point; and considerable road widenings have been undertaken throughout the routes.

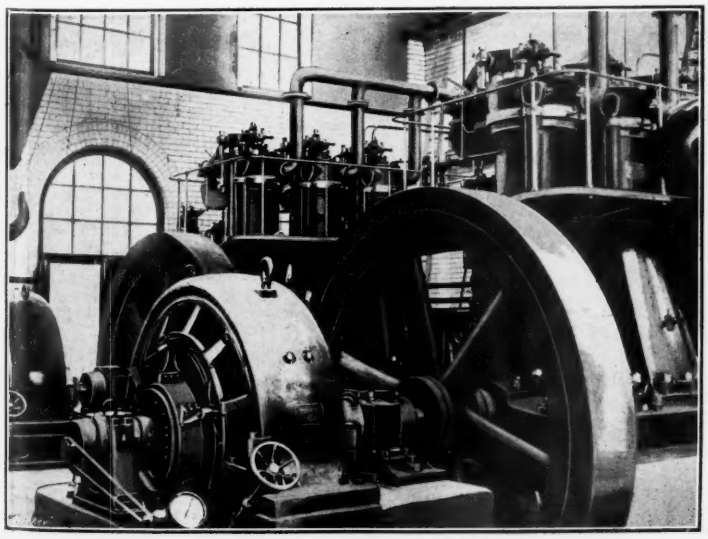
The track work and overhead equipment have been carried out by Messrs. Dick, Kerr and Co., and follow well-known practice. The gauge of the line is, of course, the same as that of Burton-on-Trent, viz., 3 ft. 6 in., and for the most part it is single track with turnouts; through Swadlincote, however, and at one or two points outside, a double track has been laid. The rails, which were supplied from the Leeds Steel Works, are 90 lb. per yard on the straight and 95 lb. per yard on curved portions of the line; the points and crossings were supplied by Messrs. Hadfield and Messrs. Edgar Allen and Co.

The trackwork is generally paved with granite, but wood paving is used in some cases, and in the tramroad section the rails are laid on wooden sleepers, ballasted with broken granite in the usual manner. Fig. 8 trolley wire, with mechanical ears and a special flexible suspension are used on the overhead work.

Owing to the large amount of single track and the number of curves, Messrs. Brecknell, Munro & Rogers's automatic signals have been installed between certain turnouts.

The cables were supplied by Messrs. Callender, and are of their vulcanised bitumen type drawn into ducts supplied by the Albion Clay Co.

The line is divided into half-mile sections in the usual way; the section



The Burton and Ashby Light Railway: View of the Diesel Engines and Tramway Generators in the Power Station.

View on the Tramroad Section, Burton and Ashby Light Railway.

boxes were supplied by Messrs. Veritys, Ltd., and are arranged for the use of portable Sterling telephones.

The rolling stock at present consists of 12 double-deck single-truck cars, each carrying 35 passengers outside and 22 inside. The car bodies and trucks were supplied by the Brush Co., while the electrical equipments, including two 40-H.P. motors and magnetic track brakes, was supplied by the British Westinghouse Co.

The power station and car-sheds are situated at Swadlincote; in the former are installed two 240-B.H.P. three-cylinder Diesel engines, each direct coupled to a 165-KW., 550-volt Westinghouse generator, with a speed of 172 r.p.m., and designed for a suitable overload capacity. The guaranteed fuel consumption at full load is ·45 lb. of oil per B.H.P.-hour. Other plant installed includes a battery of 260 cells, by Messrs. Pritchetts and Gold, working in conjunction with a Highfield reversible booster, also a negative booster. The switchboard, consisting of 12 panels, and, indeed, all the station plant, were supplied by the Westinghouse Co., either direct or through the sub-contractors mentioned.

A six months' supply of crude oil for the engines is provided in two 32-ton tanks, the oil being fed to the engines by means of a pump; the water for cylinder cooling is also stored in a cast-iron tank, over which is erected a Balcke cooling tower of the usual type.

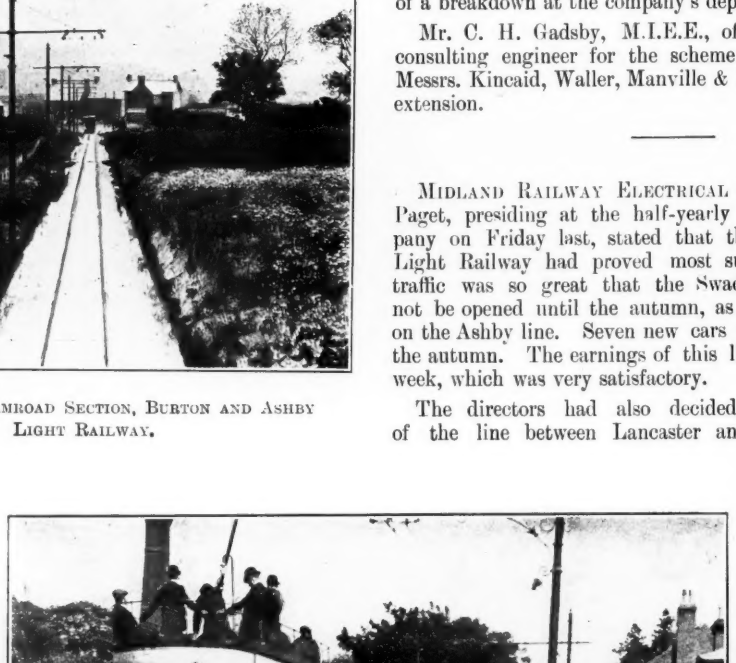
The engine room is spanned by a 15-ton travelling crane, thus facilitating repairs, &c.

A car shed built in two bays, each containing four tracks, adjoins the engine room; the tracks are provided with inspection pits, and will accommodate 16 cars. Adjoining the sheds is a well-equipped repair shop, provided with suitable machine tools. At the Burton boundary a section box with switchgear is installed, for the purpose of feeding the light railway from the Corporation power station in case of a breakdown at the company's depôt.

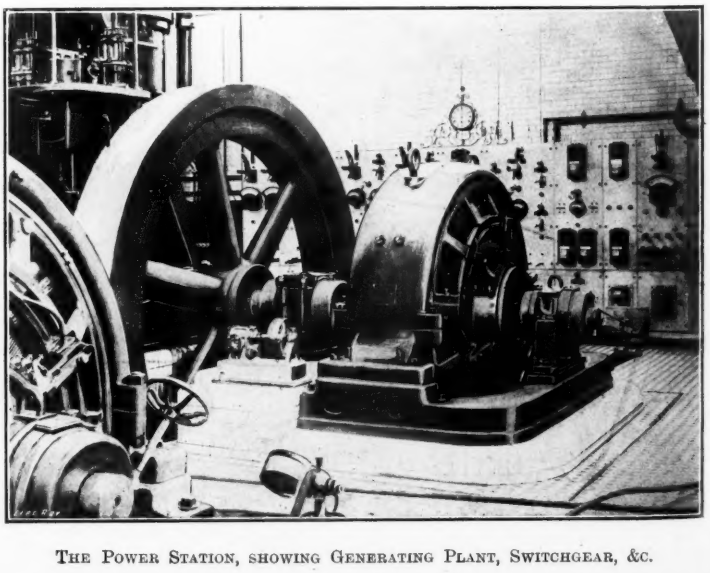
Mr. C. H. Gadsby, M.I.E.E., of Westminster, was the consulting engineer for the scheme of light railways, and Messrs. Kincaid, Waller, Manville & Dawson for the Burton extension.

Midland Railway Electrical Schemes.—Sir Ernest Paget, presiding at the half-yearly meeting of the company on Friday last, stated that the Burton and Ashby Light Railway had proved most successful; in fact, the traffic was so great that the Swadlincote branch would not be opened until the autumn, as the cars were wanted on the Ashby line. Seven new cars would be delivered in the autumn. The earnings of this line had been £350 per week, which was very satisfactory.

The directors had also decided to electrify a part of the line between Lancaster and Morecambe. They felt that their officers should have the opportunity of an object lesson of their own upon which to make whatever experiments they might think necessary in order to advise the company in the future as to the extension of electrical plant or otherwise. They had an electric power station at Heysham which they could enlarge more cheaply than they could establish a new installation. They intended to adopt the single-phase system



View on the Route in Burton.



The Power Station, showing Generating Plant, Switchgear, &c.

TRAMWAY and RAILWAY NOTES.

Australia.—ESSENDON (V.).—Good progress is being made with the construction of the electric tramway between Essendon and Flemington, and it is anticipated that the line will be open for service some time in September. The power station is situated at Flemington, and the plant comprises Browett-Lindley engines of a total capacity of 1,000 H.P.; a battery is also being installed. The rolling stock will consist of 15 motor-cars and 10 trailers, by Messrs. J. G. Brill & Co., of Philadelphia. Mr. W. G. Gordon, of the G.E. Co., of Schenectady, has been appointed manager and engineer.

SYDNEY.—An expert Committee has been appointed to inquire into and report on the efficiency of the magnetic brake in use on the King Street line of tramways. The Committee comprises Mr. T. Roberts, chief mechanical engineer, South Australian Railways; Mr. J. S. Badger, manager, Brisbane tramways; Mr. H. J. Somerset, manager and engineer to the Perth electric tramways; Prof. Pollock, Sydney University; Mr. O. Brain, electrical engineer, N.S.W. Railways and Tramways.—*Australian Mining Standard.*

Birkenshaw.—The U.D.C. has decided to object to the application for a further year's extension of time for carrying out the Spen Valley and Morley Light Railway Order.

Canada.—TORONTO.—Mr. A. A. Knudson, an expert, has been recently engaged by the City Council to investigate the amount of damage done to the water mains of the city by electrolysis, and the indications are, says our correspondent, that the city will have a big bill for damages against the Toronto Railway Co. Mr. Knudson's report, which is completed, and will shortly be submitted, shows that in Front Street 200 ft. of 12-in. cast-iron water pipe, which was only put down a few years ago, was found to be so badly pitted that it was practically destroyed. Several remedies are suggested for the elimination of the possibility of injury to the pipes and other structures in the streets. One is the use of a pole line to carry a return wire, but in view of the cost a cheaper method is mentioned, *i.e.*, that greater attention be given to the bonding of the rails. Another method suggested is that an insulating ring of rubber be placed at each joint of the pipe. The whole matter is to be thoroughly discussed at an early date by the City Council.

Continental Notes.—SWITZERLAND.—The Swiss Government is considering the question of a concession for an electric railway from Niederbipp to Alt. Solothurn. It is stated that a company is to be formed to take over the concession. The railway will be to the metre gauge, and the estimated cost is 1,341,000 fr., of which 330,000 fr. is for the superstructure, 183,500 fr. for rolling stock, 203,000 fr. for electric installation, and 105,000 fr. for the power station.

The construction of a railway over the Bernina Mountain, to connect the Upper Engadine with the Valtellina, has been planned to be carried out during 1907. The line will start from St. Moritz in the Engadine, and run by way of Pontolsina and the Bernina Hospice to Tirano in Valtellina. The track, 60 kilometres in length, is estimated to cost 12,000,000 fr. The rails will be laid on larch sleepers, the gauge being 1 metre. Energy from the electrical station at Brusio will be supplied for the working, in the form of three-phase current at 50 cycles and 23,000 volts pressure, delivered by a cable to four transformer stations, where it will be reduced to 500 volts D.C. by induction motor-generators. The dynamos will work in parallel with batteries. The current will be supplied to the motor-cars by means of overhead conductors, the return current travelling back by the rails.

The municipal authorities of Zürich have approved of the expenditure of 10,735,000 fr. on the erection of an electric power station on the Albula River.

The Grand Council of the Canton of Berne, having approved the Government's project for the construction of a railway from Frutigen to Spiez, including a tunnel through the Loetschberg, has accepted the offer of a French syndicate, at the head of which are the bankers, Messrs. Lhoeste et Cie., Paris, for its capitalisation and construction. The line will be 58,775 metres long, and the estimated cost of construction will amount to nearly 83,000,000 fr. The line will be worked electrically, 3,625,000 fr. being set apart for the electrical equipment and locomotives, 1,900,000 fr. for other rolling stock, and 76,375,100 fr. for permanent way, buildings, &c. There will be six stations and three halts within the tunnel. The line is intended to compete with the Simplon for the through Continental traffic.

SPAIN.—The Compania Generale de Tramways de Barcelona has received permission to extend its system from Jasapets to Casa Gomis and the Bonanova.

ITALY.—About six years have elapsed since consideration was first given by Italian railway experts to the question of electrical working of the trains in the Giovi tunnel, which connects Genoa through the Ligurian Appennines with the Lombardy plateau. It is hoped by the adoption of electric traction considerably to increase the capacity of the tunnel, which has for a long time been inadequate for the traffic, as, owing to the defective ventilating system, it has not been possible to dispatch the steam trains with sufficient rapidity one after another. Now the introduction of electric traction seems to be impending, as two schemes for the conversion were laid before the Italian State Railway Administration a short time ago. The first, which was prepared by Engineer Martinoli, projected the adoption of a rack rail laid between the tracks; while the second, which was suggested by Inspector Cross, aimed at the employment of two locomotives hauling heavy trains at a speed of 28 miles per hour. The administration is said to have now approved the latter scheme, and has requested the firms of Brown, Boveri & Co., Gans & Co., the Thomson-Houston Co., and the Westinghouse Co. to submit offers by the end of September for the execution of the work. It is expected that on the completion of the work of transformation the old Giovi railway will be able to deal with traffic representing 1,200 goods wagons of 18 tons capacity per day, while an additional line will have to be built to meet the future increase in the traffic.

AUSTRIA-HUNGARY.—The Ministry for Railways has empowered the town of Brixen to make technical surveys for a projected narrow gauge electric local line to start from the Brixen Station and extend by way of Their and Lajen to St. Ulrich in the Grödener Valley.

GERMANY.—An electric tramway is to be constructed at Allenstein, East Prussia.

Dublin.—The *Freeman's Journal* reports that on Thursday last a singular accident happened on the Rathmines Road, which considerably disturbed the usual morning traffic from the southern suburbs into the city. A big elm tree in the grounds of Lissonfield fell across the roadway, bending down one of the supports of the standard carrying the trolley wires. Strange to say, the wires did not give way under the heavy and sudden stress thrown on them, but supported the tree, which stretched nearly across the road, about 8 ft. from the ground. Cars continued running up to the obstruction. With considerable trouble, the breakdown gang dealt with the obstruction.

Harlesden.—The Board of Trade on the 16th inst. sanctioned the running of electric cars along Harrow Road to the bridge over the River Brent. The secretary of the Metropolitan Electric Tramways Co. has stated that the Board of Trade inspection was, for purposes of convenience, held early, and that it is not intended to open the line before the beginning of October.

Harwood.—The B. of T. has informed the U.D.C. that a year's extension has been granted for completing the Blackburn, Whalley and Padiham Light Railways.

Kirkcaldy.—On the 14th inst. the Kirkcaldy to Leven tramway system was inspected by Colonel Von Donop, of the B. of T.

Lancashire.—The Lancashire United Tramways Co. on the 17th inst., completed its section from Winton to Boothstown. It is now possible to travel by tramcar from Liverpool landing stage to the Manchester Exchange, with two changes.

Llandudno-Colwyn Bay.—The Colwyn Bay T.C. has granted to the promotors of the Llandudno-Colwyn Bay light railway scheme a further extension of time to June 1st next, to complete the line from Llandudno to Colwyn Bay, provided that all works on roads and highways in the district are completed by March 1st next. The agreement with the Llandudno and District Electric Tramway Construction Co., as approved by the sub-committee of the Council, has been sealed by the Council.

London.—L.C.C.—The report of the district auditor on the accounts of the Council for the year ended March 31st, 1905, has been issued. The amounts carried to the appropriation account from the respective tramway revenue accounts were:—Northern system—surplus, £22,836; southern system, surplus, £7,055, a total of £29,891. The general revenue account showed a deficiency of £18,467, leaving a net surplus of £11,424, against £8,695 in the previous year. The balance to the credit of the appropriation account at March last year amounted to £20,989. The sum of £35,000 was transferred during the year from the southern system revenue account to the renewals reserve fund, the amount then standing to the credit of this fund being £66,607. It is understood that the Council has under consideration the question of the adequacy of the amounts placed to the credit of the tramway renewals and reserve fund. The Council, the auditor was informed, is endeavouring to settle some definite basis upon which such contributions shall in the future be calculated. Attention is drawn in the report to the great decrease in the rents received from the North Metropolitan Co. During the year to March 31st, 1905, these rents amounted to £59,576 as compared with £64,758 in the previous year. Up to the same date an aggregate amount of £89,305 has been charged to the tramways account in respect of expenditure on street widenings in connection with tramways. In 23 cases the Council decided that the tramways account should bear a proportion of the cost, and in one case the whole of the cost. The total sum estimated to be chargeable to the tramways account in these cases is £377,620. The proportions vary, but the auditor points out that the fixing of these proportions seems to him to be of a somewhat arbitrary character. He understands that several committees have the matter under consideration.

Considerable inconvenience was caused on Saturday morning last by the stoppage of all the cars on the southern system between 8 and 9 a.m. The occurrence was stated to be due to an interruption of supply from the Greenwich generating station.

Two more drivers were fined 5s. and 2s. costs on Tuesday last for exceeding the speed limit of 10 miles per hour in the New Kent Road.

Metropolitan District Railway.—A full list of new fares has been prepared, and they are to come into operation at the beginning of next month. In many cases the single fare has been increased, and in a few reduced, but return tickets are, in the near future, to cost exactly double the single fare. Substantial increases will also be made in workmen's fares. Long-period season tickets are again to be issued.

The subject of increase of workmen's fares on the M.D. Railway was touched upon at the conference of the delegates of the National Association for the Extension of Workmen's Trains and Trams, held on Saturday last. Mr. G. Drew, the hon. secretary, said he was sorry Sir Geo. Gibb "had gone out of his way" to make statements regarding workmen's fares. It would seem that the Association expects a railway company to run trains to suit the convenience of "workers," and to sustain a loss on the deal. In fact, a railway company ought to be solely a philanthropic concern. This is on a par with an idea that occurred to "General" Booth, of the Salvation Army, when speaking at Bath about a week ago. It occurred to him that land could be made profitable by a municipality erecting cottages on it and running a system of tramways in the district, free to the municipal tenants.

Islington.—Work has been commenced in connection with the Highbury extension of the Aldwych-Angel section of the L.C.C. tramways.

Hackney.—Considerable opposition is to be offered in the district to the L.C.C. proposals to spend about £50,000 on three new short lines to connect Stoke Newington and Dalston with Hackney.

Paddington.—The Harrow Road Tramways Co. announces that the horse cars will cease running on September 1st, in order to facilitate the electrification of the line to the point where it joins the already completed Harlesden section of the Middlesex C.C. system.

Mersey Railway.—The report for the first half of 1906 shows that the number of passengers carried increased from 4,862,378 to 5,352,867, and the gross receipts from £43,537 to £47,129. The working expenses were £35,046, as against £34,728. The net revenue was £12,182, as compared with £8,809, and after meeting net revenue charges a deficit of £10 is added to the debit balance in the balance-sheet, making the total £8,451.

Salford.—A report on the past year's working of the Salford Corporation Tramways was issued last week. The total length of the tramways operated is 74¾ miles, of which 36½ miles are owned by the Corporation, and the remainder leased from the authorities of Eccles, Swinton and Pendlebury, Prestwich, and Whitefield. The traffic receipts show an increase of £13,594, as compared with the previous year. The number of passengers carried was 41,807,539. The year's working resulted in a gross profit of £79,713—a sum of £2,105 for interest on investments bringing up the available total to £81,818, which is dealt with as follows: Payments to local authorities for running powers, £19,557; interest and sinking fund charges, £39,959; contribution in relief of rates, £13,000; depreciation and renewals fund, £9,302. The amount now standing to the credit of the depreciation and renewals fund is £30,439. The manager, Mr. G. W. Holford, remarks: The abstract of accounts of this undertaking indicates its growing character and importance in a striking degree. The amount paid for electrical energy during the year was £48,574, a sum which justly entitles the Tramway Committee to more favourable consideration from the Electricity Committee than it has yet had. In addition to the contributions in aid of rates, from gross profits, £6,565 was paid in rates from revenue. During the year £11,294 has been expended in repairs to cars and permanent way. Repairs to overhead equipment cost £2,830. There has also been paid in rent for lines to the Manchester Corporation £9,012, Eccles Corporation £7,050, Prestwich U.D.C. £2,320, Whitefield U.D.C. £456, and Trafford Park Estates Co. £719. The gross capital expenditure to March 31st last was £657,564.

Surbiton.—Victoria Road and part of Ewell Road are in a bad condition, and the Council contends that the cost of repair should fall on the L.U. Tramways. Sir Clifton Robinson denies the responsibility; he is to be invited to a meeting to discuss the matter, pending further action.

U.S.A.—New York.—The rioting on the line of the Brooklyn Rapid Transit Co. has resulted in the capture of more than 100 prisoners, who are to be arraigned at the Police Courts. The situation is so serious that the question of calling out a regiment of Militia is being discussed.

Wellingborough.—The U.D.C. has been informed that a local syndicate is being formed with a view of promoting a tramway scheme for the town and district. The promoters have been asked to discuss the matter with the Council.

Wimbledon.—The *Standard* states that the dispute between the Corporation and the L.U. Tramways still remains unsettled. The Corporation insists upon the company giving "satisfactory assurances" that the proposed line from South Wimbledon to Tooting will be commenced without delay before it gives its sanction. Sir Clifton Robinson, on behalf of the company, has already declared that it is in the company's interests to go on with the extension to Tooting, so that it may have a connection with the County Council's southern system, and that the work will be started as early as possible. It is understood that the Corporation has now called upon the company to deposit a sum of £20,000 as a guarantee.

Wood Green.—The work of laying the new lines from Wood Green to New Southgate is proceeding, and it is hoped to complete it by Christmas. The contractors for the laying of the line from Wood Green to Enfield have received instructions to commence work.

TELEGRAPH and TELEPHONE NOTES.

Birmingham.—A large central exchange is to be built by the National Telephone Co. in Birmingham, to provide for 10,000 lines.

Brazil.—The year 1903 was a prosperous one for the various branches of the Brazilian telegraph and telephone services. The traffic and the maintenance of the lines improved, as well as the receipts. New instruments on the Baudot system have been installed with great success on the main line south of Rio Janeiro, and greatly facilitate the circulation of traffic, and it is intended to introduce them on the system as far as Fortaleza. The 471 offices of the Administration handled a very large number of messages, the reason for the increase being the large number of "deferred telegrams." Owing to the new sums voted by the Government it has been possible to make improvements on the line between Rio Grande and Recife, which carries most of the International traffic. The service between Para and Manaos, which is maintained by the river cables of the Amazon Telegraph Co., still leaves much to be desired, and only partially meets the commercial requirements. Notwithstanding the annual subsidy of £10,000 granted to the company by the Amazon State, it has ceased to operate the landline erected alongside the river between Manaos and Parentins, owing to the difficulties of maintenance, and wireless concessions have, therefore, been granted. The Brazilian system at the end of 1903 totalled 24,395 kilometres of line and 47,359 of wire—being an increase of 1,809 and 2,718 kilometres of line and wire respectively. Of submarine and river cables there were 78,189 kilometres with a length of wire of 136,669 kilometres. The Government Department for War also erected various new lines to the interior of the country. 2,694 interruptions of the telegraphic service occurred in 1903, but naturally the long distances account for much delay in repairing. For the purpose of introducing wireless telegraphy between Rio Janeiro and Santos, the delegate to the Conference was instructed, while in Europe, to study the various systems in order to find the most suitable for this purpose, but in consequence of the report of the delegate, trials in wireless have been postponed till this system has been further improved.

Traffic.—The interior traffic amounted to 1,128,668 telegrams, containing 17,401,554 words, in 1902, while in 1903 the figures were 1,295,243 telegrams and 21,015,755 words. The increase, therefore, is 166,575 telegrams and 3,614,201 words. Owing to the constant interruption of the route *vid* Pinheiro, very little use was made of the French Co.'s cables. The Western Telegraph Co.'s cables, however, worked regularly during the year. The latter company secured 164,612 telegrams going direct to and from Recife, while the South American Cable Co. only secured 2,068. Of the 164,612, 131,141 were private and 10,752 press telegrams. 6,711 telegrams containing 53,617 words destined for places on the Southern routes were transmitted by the landlines, of which 6,695 telegrams and 53,363 words are claimed by the South American Cable Co.

Telephones.—This service is represented by six central stations controlling 353 conductors, but owing to strong earth currents the service has not been successful. The alteration of the route in order to overcome this difficulty has not proved satisfactory, and the Government think that underground wires only can be successful. The total receipts on account of the telegraphs amounted to 7,981,828 fr., whereas the expenses amounted to 9,594,373 fr.

Chile.—It was officially announced by Berne last week-end that the Western Telegraph Co. received advice from Buenos Ayres that all aerial telegraph lines to Chile and Peru were interrupted by reason of the earthquake which visited Valparaiso. It was also announced in the Press that all cable communication was interrupted. Shocks were recorded by seismographs at Washington, and excellent records were secured at Dr. Milne's observatory at Newport, Isle of Wight. However, the whole situation telegraphically is reflected by the notice in the *Post Office Circular*, stating that telegrams for Argentine, Paraguay, Uruguay, Chile, South of Valparaiso, ordered *vid* Galverton, and for Peru and Chile by the eastern routes "*vid* France, Teneriffe and Noronka," or "*vid* France-Dakar," can only be accepted at the risk of the senders.

Glasgow.—The report of the Corporation Telephone Department for the year which ended on March 31st, states that the revenue amounted to £57,461 as compared with £55,426 in the preceding year. The working expenditure, including Post Office royalty of £5,727 and terminal fees £795, was £36,768, leaving a net revenue for the year of £20,693, out of which the following requirements had to be met:—Interest on loans fund, £9,674; sinking fund, £10,970; total, £20,644, leaving a surplus on the year's operations of £48, as compared with £1,504 in 1904-5. Referring to the decision to sell the system to the Government for £305,000, the report states that the loss which it is expected the Telephone Department will sustain by the sale to the Post Office is estimated at about £15,000.

Manchester.—The National Telephone Co. is purchasing a site at the corner of York Street and George Street, Manchester, for the erection of a new exchange. Provision is to be made for 10,000 lines, and the exchange will be equipped with all modern improvements for giving a first-class service. The work is to be entered upon at once.

National Telephone Co.—It is reported that a large number of mechanics employed by the National Telephone Co. were dismissed during last week, the total approximating to 500 men, of whom 300 are stationed in London. The company, it is stated, does not admit that the numbers are so great as alleged, and explains that the reduction is merely temporary, during the slack season.

New German Cable.—A correspondent of the *Times* states that the second section of the cable connecting Germany with German South-West Africa is now being laid. It is about 4,000 miles long, and runs from Vigo, in Spain, to Walfisch Bay. The first section lies between Emden and Vigo, and is 2,099 miles long; it was laid in 1894-6.

Press Telegrams.—The Postmaster-General has issued regulations dated August 16th on the subject of foreign-written Press telegrams, copies of which regulations are now available.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Trinidad-Demerara (No. 1.)	Aug. 26, 1901	
Dominica-Martinique	May 7, 1902	
St. Lucia-Martinique	May 7, 1902	
Reissa-Issa (Yemen) Camaran	Oct. 22, 1902	
Cayenne-Pinheiro	Aug. 18, 1902	
Port Arthur-Chifu (Closed)	Mar. 7, 1904	
Tarifa-Tangier	Jan. 18, 1904	
Garachico (Tenerif)-Santa Cruz	July 12, 1906	
Bolamo-Bissao	July 24, 1906	
Curacao-La Guayra / Curacao-Coro	Jan. 11, 1906	
Rhodes-Sitia	Aug. 10, 1906	Aug. 17
Falmouth-Bilbao	Aug. 14, 1906	
Mole St. Nicholas-Port au Prince	Aug. 16, 1906	
Communication with Chile and Peru	Aug. 16, 1906	
Landlines.		
Puerto-Barrios	Aug. 28, 1902	
Bachkale-Deliman	Feb. 12, 1906	
Bagdad-Bassorah	July 17, 1906	

Telephone Cable.—Experiments are in progress at Lake Constance with a submarine telephone cable constructed on Prof. Pupin's system, 7 miles long and at a maximum depth of 820 ft., by the Siemens-Halske Co. By this means communication has been effected between Berlin and Switzerland.

West African Telegraph Stations.—The African Direct Telegraph Co. have stated their determination to close the station at Brass unless a guarantee of £1,000 per annum is given. The chairman of the Liverpool Chamber of Commerce recently stated that the Government had guaranteed £300 per annum, and after considering the matter it was decided to communicate with members interested in trade with Brass to see if they were willing to join in the guarantee.

CONTRACTS OPEN and CLOSED.

OPEN.

Bolton.—August 30th. Three-phase extra-high-tension switchboard for the Corporation. See "Official Notices" August 17th.

Dublin.—September 8th. Arc lamps and arc lamp pillars for the Corporation. See "Official Notices" to-day.

Dundee.—August 31st. The T.C. invites tenders for 300 tons of tramway rails, fixings, points and crossings. Specifications, quantities, forms of tender, from Jas. Thomson, Burgh Engineer, on payment of two guineas. Sealed tenders, endorsed "Rails and Fixings," to W. H. Blyth Martin, Esq., Town Clerk.

Edinburgh.—September 12th. Electrical wiring and fittings for the Police Fire Station, at Stockbridge. See "Official Notices" August 17th.

Epsom.—August 31st. One 300-KW. steam dynamo, water-tube boiler, condenser, induced-draught apparatus, for the U.D.C. electric lighting extensions. See "Official Notices" August 17th.

Germany.—The municipal authorities of Allenstein are about to invite tenders for the establishment of a central electric lighting station in the town, at an estimated cost of £26,500.

Halifax.—August 28th. Lead-sheathed feeder cables for the Tramways and Electricity Committee. See "Official Notices" to-day.

Handsworth.—September 15th. Electric wiring for the Council's new schools. See "Official Notices" August 10th.

Margate.—September 3rd. The Council invites tenders for an E.L. installation at the Wingham Pumping Station. See "Official Notices" to-day.

Melbourne.—September 18th. The *Commonwealth Gazette* notifies that tenders will be received at the office of the Deputy Postmaster-General, Melbourne, until noon on Tuesday, September 18th, 1906, for the supply and delivery, at Melbourne, of:—

1. Five miles of 78-pair lead-covered paper-insulated telephone cable, with 20-lb. per mile conductors.
2. Two and a half miles of 26-pair lead-covered paper-insulated telephone cable, with 20-lb. per mile conductors.
3. One and a quarter miles of 26-pair lead-covered paper-insulated telegraph cable, with 25-lb. per mile conductors. (The conductors to be insulated with two thicknesses of dry Manilla paper; the diameter and the capacity of the cable not being limited.)

Tender forms embodying specification, &c., from General Post Offices, Melbourne, Sydney, Brisbane, and Adelaide. Tenders must be endorsed and addressed to the Deputy Postmaster-General, Melbourne.

Oxford.—September 17th. The Corporation invites tenders for the reconstruction, extension, and electrical equipment of the existing horse tramways, and the leasing thereof. Proposals based upon the overhead system of electric tramways will not be considered. The conditions of tender may be obtained from the town clerk on deposit of Bank of England notes to value of £100. Tenders to the Town Clerk, endorsed "Tender for Tramways," delivered at Town Hall, Oxford.

Rathmines (Co. Dublin).—September 12th. The U.D.C. wants tenders for electricity supply mains, house fuse boxes, house meters, extension of switchboard, extension of accumulators, and battery booster. See "Official Notices" to-day.

St. Pancras.—September 5th. One 2,000-KW. steam turbo-generator, switchboard, condensing plant, &c.; two 500-KW. three-phase motors coupled to continuous-current generators, switchboards, &c., for the Borough Council. See "Official Notices" August 17th.

Stoke-upon-Trent.—September 5th. Electric wiring of workhouse premises. See "Official Notices" August 17th.

CLOSED.

Admiralty.—The Cantie Switch Manufacturing Co. have again been successful in booking two large contracts for switches for Admiralty gun-firing panels.

Barking.—The U.D.C. has accepted the following tenders for the extension of the tramways:—

Messrs. Dick, Kerr & Co., Ltd.—Overhead equipment, £292 8s. 6d.
Mr. D. T. Jackson, Barking.—Fish-plates, rails, &c., £598 5s. 3d.; permanent way construction, £3,806 14s. 8d.

Birmingham.—Messrs. Handley & Shanks have secured an important contract from the Great Western Railway Co. for the electric lighting of their Birmingham hotel.

Brush Contracts.—The following contracts have recently been placed with the Brush Electrical Engineering Co., Ltd.:—

Swansea Improvements and Tramways Co.—One 14 in. × 20 in. locomotive.
Dundee and Broughty Ferry Tramways (per B.T.-H. Co.).—Two double-deck car-bodies and trucks.
N.S.W. (Government, Traction Department.—Three fixed-base trucks, one radial truck.
Para (Brazil) (per J. G. White & Co.).—24 car-bodies.
Electric Lighting and Traction Co. of Australia.—Four 50-KW. transformers.

France.—The French Post and Telegraph authorities in Paris have lately given out contracts as follows:—La Société Industrielle des Telephones, Paris, 40 kilometres of rubber-insulated (single conductor) telephone cable, 44 kilometres lead-sheathed ditto (double rubber-insulated conductor), and 9½ kilometres rubber-insulated ditto (with seven pairs of conductors), at £3,624.

London.—The Linolite Co., of 25, Victoria Street, Westminster, have received an order for 607 ft. of "Linolite," to be installed in the new Sessions House (on the site of Newgate Prison.) They have previously supplied 240 ft. for the same building to Messrs. H. J. Cash & Co., of Tothill Street, S.W., who are carrying out the electric lighting.

Mansfield.—The T.C. has accepted the tender of the D.P. Battery Co., Ltd., for the maintenance of the battery for 11 years.

Musselburgh.—The T.C. has accepted the tender of the National Electric Construction Co. for wiring at the new infectious diseases hospital. The company's complete tender amounted to £447, but this included fittings and cable, which are still under discussion.

Rochdale.—The T.C. has accepted the tender of Messrs. W. T. Glover & Co. for the supply of cable for the extension of the mains to Castleton.

The Mirrlees Watson Co., Ltd., of Glasgow, have received orders for the following condensing installations:—

SURFACE CONDENSING PLANT.

Greenock Corporation.—One set, duty 30,000 lb.
Bordeaux.—(Per Compagnie Française pour l'Exploitation des Procédés Thomson-Houston), two sets each 66,000 lb.
H.M. War Office, Enfield Lock.—One set, duty 20,000 lb.
Lancashire Electric Power Co., Radcliffe.—(Per Messrs. British Thomson-Houston Co., Ltd.), one set, duty 87,000 lb. (Repeat order.)
Wolverhampton Corporation.—One set, duty 20,000 lb.
Leeds Corporation.—One set (per Messrs. Willans & Robinson), duty 65,000 lb.
Hastings Corporation.—(Per Messrs. Willans & Robinson), one set, duty 15,000 lb.
Great Central Railway Co.—(Per Messrs. The British Westinghouse Co.), two sets, duty each 12,500 lb.
Sheepbridge Coal and Iron Co., Ltd., Glapwell Colliery.—One set, duty 85,000 lb.
Maidstone Corporation.—One set, duty 20,000 lb.
Bristol Corporation.—(Per Messrs. The British Westinghouse Co.), one set, duty 62,000 lb. (Repeat order.)
St. Petersburg Tramways.—(Per Messrs. The British Westinghouse Co.), three sets, duty each 38,500 lb.

BAROMETRIC CONDENSING PLANT.

David Colville & Sons, Ltd.—One set, duty 80,000 lb.
Borough of Gravesend.—One set, duty 16,000 lb.
San Nicolas Tolentino.—(Per Mr. Arthur Williams), one set, duty 6,000 lb.
Bolckow, Vaughan & Co.—(Per Mr. P. J. Mitchell), one set, duty 44,000 lb.

Walsall.—The T.C. has accepted the tender of the Walsall Electrical Co., Ltd., for the supply of a Tangye engine and pump, at £93 13s.

NOTES.

Electrical Production of Steel in Sweden.—A Stockholm correspondent announces that Swedish capitalists and manufacturers have submitted a scheme to the Government, which aims at the electrical production of steel according to the process devised by Messrs. Grondal & Kjellin. The proposal is to form a company to erect works in the district of Goteborg and on Norrland, provided that the Government will utilise the waterfalls in the vicinity and supply the power to the company. In the case of the projected works near Goteborg the intention is to produce 500,000 tons of iron and steel per annum by means of electrical energy supplied by the utilisation of the Trollhatta waterfall, and a similar tonnage is foreshadowed for the works on Norrland. It is pointed out that an annual output of 1,000,000 tons of steel would not only meet the inland demand in respect of steel for warships and guns, and for railway rails, joists, &c., but it would also permit of the creation of a large export trade owing to the low cost of production by means of water power and the cheapness of labour. The Government after due consideration has agreed to the proposal. The company is to bear the title of the Metallurgiska Patent Aktiebolaget, and it has already been settled that the Trollhatta falls shall be brought into use for the purpose in view. It is assumed that the undertaking will have about 15,000 H.P. at its disposal in 1908. The F. Krupp Co. is understood to have purchased the rights to work the process in Germany, while Messrs. Vickers, Sons & Maxim are credited with the possession of the same privilege for England.

Lightning Conductors.—Notwithstanding all that has been said by Sir Oliver Lodge and the subsequent deliberations of the Lightning Conductor Committee to prevent injury from electrical storms, immense damage occurs annually to life and property, and the newspaper record of the past few weeks is no exception to the rule. This would indicate that valuable buildings are still left without any protection whatever, or if it is provided, their maintenance has been entirely neglected. The fact cannot be too strongly emphasised that a lightning conductor is worse than useless—nay, more—is a source of real danger, unless kept in good condition, especially at its base. Within the past two years, says a correspondent, we were invited to inspect a conductor which was considered not *quite* satisfactory. To speak frankly, the finial was passable, the rope not less so, but at the point of termination the end of this wire rope was coiled spiral shape and stuffed inside an antiquated oven which had been placed in the ground alongside the building. The oven lid was level with the pavement, so that when it was open, examination could be effected and when closed, it would afford protection to passers-by lest they should fall therein. A very ingenious arrangement. The conductor was covered with verdigris and the iron receptacle was quite dry. On inquiry we learned that it was the coachman's duty to refill this old oven with a gallon of water once per month, but owing to pressure of business the matter had inadvertently been overlooked.

Aluminium Solder.—The most satisfactory alloy for soldering aluminium consists of 1 part of aluminium, 1 part of phosphor tin, 11 of zinc and 29 of tin. To avoid loss of the more easily volatile of these metals the aluminium is melted first, then zinc is added in small pieces, then tin in small pieces, and lastly the phosphor-tin. For the soldering no acid is used, but the surfaces to be joined are first covered with a thin coat of the solder in the usual way and then brought together and heated with the soldering copper or a blow-pipe or torch until the solder already upon them is melted, when pressure is applied and the joint is made. Aluminium must be heated to about 660° F. before it can be soldered.—*Iron Age.*

Lightning Statistics for Germany.—It appears to be the practice for statistics to be officially collected every year in regard to the cases recorded of damage caused by lightning in Prussia. The figures relate to what are termed (1) "kindling strikes," or cases where lightning causes fire, and (2) to "cold strikes," or instances where damage is done without producing a fire. The following table is a summary of the most recent statistics in respect of the first class of strikes:—

Year.	Total number of kindling strikes.	Number in towns.	Number in country districts.
1885	1,327	155	1,172
1887	766	137	629
1888	936	—	—
1895	1,620	221	1,399
1900	1,434	—	—
1902	824	—	—
1903	813	—	—

In 1889 and in each of the years to 1893 inclusive the number of the more dangerous class of strikes exceeded 1,000. The maximum number was reached in 1895 with 1,620, as shown in the table, when the damage, taken in conjunction with the 213 "cold strikes" in that year, represented no less than £325,600. This sum is, however, slightly less than the £328,450 damages caused in 1900 by the 1,434 kindling and the 639 cold strikes which took place in that year. The greater portion of the destruction of property happened in country districts, although the adoption of lightning conductors in recent years is said to be also affording the country localities a larger measure of protection.

A Rand Menu.—A dinner was given recently by five of the principal contractors for the Johannesburg Tramway and Lighting Scheme to the Mayor and the principal officials. The following is the menu, which sufficiently indicates the enjoyable nature of the repast. We are pleased to note that the overload test was omitted:—

CARLTON HOTEL, JOHANNESBURG.

Dinner given by the British Westinghouse Co., Ltd.; Dick, Kerr and Co., Ltd.; W. T. Glover & Co., Ltd.; Siemens Bros. & Co., Ltd.; D. Stewart & Co. (1902), Ltd., July 27th, 1906.

TOASTS.

"The King."
"Success to the Johannesburg Electric Scheme."

WINES.

STARTING.
Rheostat Sherry.

QUARTER-LOAD.
Ammonia Water (Oechelhäuser).

HALF-LOAD—Steady.
Pressure Test Champagne.

THREE-QUARTER LOAD.
Exhaust Port.

FULL LOAD.
Ignition Proof Whisky.
Two-phase Brandy.

SHUT-DOWN.
High-voltage Cigars.

MENU.

NOTE.—The switchboards will be fitted with all needful apparatus to ensure ease. Stuffing boxes lined with elastic cushions.

Courses in Series. Items in parallel, if desired.

SOUP.
Consommé Diatrine. Potage à la Valvoline.

FISH.
Sole Plates.
Boiled Crab winch without tangential pull.

ENTREES.
Bipolar magnets with granulated carbon.
Rheostat Simple. Engineers' Grouse.

JOINTS.
Hot Crosshead with Hose Sauce.
Boiled Silencer stuffed with stones.

VEGETABLES.
Baked, Boiled and Mashed Bearings.
Boiled Boulders, Chipped Screenings.

SWEETS.
Contractors' Custhard.
Producer Trifles. Trolley-polley Pudding.

Savory.—Extras in writing.
Coffee.—Black Lubricating Compound.
Balancers, Equalisers, Tar-Tar 'Ohms.
Full load at high pressure guaranteed.

Electric Shock Fatality.—At the inquest held in connection with the death from electric shock, of a fore overman employed at the Dean and Chapter Colliery, Ferryhill (p. 265 last week's issue), William Henry Thompson, deputy of Dean Bank, said he saw Mr. Walton fall, and ran to his assistance. As soon as he touched Mr. Walton he was flung off. He then set off to run to the colliery to get the engine stopped; the latter was, however, stopped before he got there. When he returned, both Mr. Walton and the boys were off the wires. The boys regained consciousness and came round all right.

Mr. Hann, resident manager of the colliery, said there was an electric installation both on the surface and underground. Overhead wires were carried on poles up the incline to Dean Bank, and two of the wires, at 220 volts, conveyed the current for lighting his house. There were three other wires at 500 volts conveying power for the working of a pug mill. A wire rope was fixed to one of the poles as a stay at the top of the incline, and the cables above were all insulated. The wire stay had got loose, a wooden peg in the ground having been removed. At the time of the accident the wire was wrapped partly round the pole. The wire stay having been loosened, the wire at the top fell into contact with one of the cables. The insulation was not quite perfect, just at that part there being a small hole into which a pencil point might be inserted. It was a very wet day, and water might have got into the hole and thus set up a connection through to the wire stay. He had not had any complaint as to children swinging on the wire stay.

The Coroner asked if any steps could be taken to obviate danger in the future?

Witness said that in future the stay would be placed below the cables so that there could be no contact. They would also place an insulator on the wire at the connection with the pole.

A juryman suggested that the pole could be removed to a safer position. The Jury returned a verdict of "Accidental Death."

Confusion of Ideas.—Mr. J. G. McLean, engineer and manager of the Woking Electric Supply Co., Ltd., sends us a post card which he has received, unstamped, and inscribed as follows:—"Hull, August 4th, 1906. Sir,—Why don't you appoint the man at once without sending advertisement to the magazines when you have already made up your mind whom you are going to send to this position?"

This polite communication clearly emanates from one who has been in the habit of applying for municipal appointments, and has failed to note that Woking electricity supply is in the hands of a company. The fact that in far too many cases appointments under Corporations are allotted to the *protégés* of influential councillors or local magnates, and that the posts are advertised merely as a matter of form, to cover the transaction, is notorious; but this does not apply to a company, which has to consider ability rather than influence in selecting its employés, and has no reason whatever for inserting an advertisement if a suitable man is at hand.

Explosion in Manchester.—A more than usually serious explosion, attributed to a fusion of electric wires, took place in Victoria Street, on Thursday last week. There were really two explosions—the first in the basement of Messrs. John Williams and Son's grocery establishment; the second, a few moments later, in a manhole under the street pavement a few yards from Messrs. Williams's premises. Most of the damage was done by the first explosion, which damaged the building considerably. The second explosion forced up the manhole cover, threw down several passers-by, and blew in the windows of Messrs. Hime & Addison's pianoforte establishment. No one was seriously injured, but the wreckage of property was extensive.

After the occurrence, the scene of the explosion was visited by Mr. Howarth, chairman of the Manchester Electricity Committee, and Mr. S. L. Pearce, the chief electrical engineer, and an official statement has since been published. It was found that the electric distributing mains, laid in 1898, had been burnt away for a distance of about 6 ft. The fusing of the mains commenced at a point where the service wires to Messrs. Williams's premises left the distributing mains. No positive reason can be given for the failure, but in the present case, it is believed that the heat generated by the fusion of the wires volatilised the bitumen, and the gases given off formed an explosive mixture.

Competition for Primary and Secondary Cells.—An international competition has been opened by the Association des Industriels de France for the invention of a primary cell and a storage cell satisfying certain conditions. Both cells are to develop the maximum power or contain the maximum energy possible per unit of weight and bulk, and they must be free from risk of every description to the users, easy to transport, install and maintain. The samples submitted are not to weigh more than 20 kg. Complete descriptions of the cells must be forwarded by the competitors before December 31st, 1906, to the President of the Association, 3, Rue de Lutèce, Paris, with drawings, and the actual cells must be ready for dispatch to the examiners by April 1st, 1907. The total prize money amounts to 8,000 fr., which will be awarded as a lump sum or divided at the discretion of the Association, to which intending competitors should apply for full particulars.

Electric Ambulances for London.—The City Corporation has decided to inaugurate a motor ambulance service, which is expected to be in working order before the end of year. There are to be over 50 call stations. These will be distributed over the City, and will be similar in appearance to the existing fire alarms. The purchase of two electric motor ambulances is provided for by the scheme, but only one, to cost between £400 and £500, has yet been ordered, it being considered desirable to gain some experience in working before a second is acquired.

Royal Engineers.—Changes are being made in the organisation of the field units of the Royal Engineers, which affect the electrical branches. One searchlight unit, divisible into two sections, each equipped with two generators and projectors, will be maintained. The new telegraph establishments provide for one line of communication telegraph company, two air-line, two cable, two wireless, and six divisional telegraph companies, instead of the three existing telegraph companies.

A Celluloid Substitute.—An American Consular report from Reichenberg gives particulars of a discovery of a complete substitute for celluloid, which is not yet patented, or on the market. The substitute is only a little dearer than glass, and of about the same weight. It is very elastic, will not burn, and is very easy to work and polish. The material is without smell and is a non-conductor of electricity.

Appointments Vacant.—Mains and distribution supervisor for H.M. Dockyard, Sheerness (48s. per week); instructor in electrical engineering for Crawford Municipal Technical Institute, Cork, at £200; instructor for evening classes in electric light and power transmission at the East Ham Technical College (10s. 6d. per evening). See our "Official Notices" to-day.

A Compulsory Winding-Up.—In the Vacation Court on Wednesday, before Mr. Justice Sutton, application was made for the winding-up of the Empire Electric Light and Power Co. on the petition of the Tudor Accumulator Co., Ltd. Counsel for the company asked that the matter might stand over. The petition stated that the directors of the company were guilty of a fraudulent preference in favour of a firm of solicitors, by issuing to them debentures contrary to an agreement with creditors not to issue any further debentures. That was a matter which certainly ought to be properly inquired into. His Lordship said he saw no reason for departing from the ordinary course, and made a compulsory winding-up order.

Electric Flat-Irons.—A correspondent writes:—"I recently saw some allusions in the ELECTRICAL REVIEW, or in one of your contemporaries, to an attempted boom in flat-irons; and, having regard to the fact that at least one large house in England has suffered from electric fires caused by such irons, I would suggest that they be *not* largely introduced into this country unless fitted with a time switch or other automatic device, by which all overheating may be prevented in case an iron is left to itself for a time with the current full on, while the user of the iron is absent from her work.

"ONE WHO KNOWS."

It is, unfortunately, the fact that disastrous fires have been caused by the misuse of this humble domestic implement, though it is harmless when in discreet hands.

The reference appears to be to a leading article, followed later by a note, in our valued contemporary *Electrical Industries*, describing various methods adopted in America for introducing electric flat-irons into consumers' houses. "The demand is not equal to the supply," we are told. Is this irony?

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the ELECTRICAL REVIEW posted as to their movements.

Central Station Engineers.—Mr. G. W. GROSSET, engineer-in-charge at the Bradford Corporation Electricity Works, Valley Road, is resigning his position on the 31st ult. to take up an appointment as "Station Supervisor" under the Admiralty.

The Portsmouth T.C. has increased the salary of Mr. W. S. FOALE, electrical engineer and manager, from £400 to £500 per annum.

Tramway Officials.—With reference to a note which appeared in this column in our issue of the 10th inst. as this appears to convey the impression that the offer of the appointment of "Advisory Engineer" to the Dover tramways was declined by Mr. L. W. WOODMAN, the borough electrical engineer, we are asked to point out that such was not strictly the case. On being asked by the Tramways Committee whether he would accept the appointment, Mr. Woodman submitted the conditions under which he was prepared to do so. These conditions referred mainly to the duties and responsibilities attaching to the appointment, which he desired should be restricted and at the same time well defined. The Committee, however, were unable to agree to the terms, and have consequently made no appointment.

Mr. G. R. BLACKBURN, late of the Bradford tramways, who was recently appointed superintendent of the rolling stock department of the Manchester tramways, is to receive a suitable presentation from the Leeds Section of the Institution of Electrical Engineers, in recognition of his work in forming the section and in acting as its honorary secretary and treasurer.

The Nelson Corporation has under consideration a resolution recommending the appointment of Mr. HELM as electrical engineer and tramways manager, at a commencing salary of £150

Mr. Helm has for some years been chief assistant. The late Mr. Henry, it will be remembered, was killed in a cycling accident.

The Walsall T.C. has adopted the recommendation to increase the salary of Mr. R. L. Horsfield, tramways manager, from £250 to £300 a year as from October 1st next.

General.—Mr. T. J. Seaman, for many years with Messrs. Macartney, McElroy & Co., Ltd., has joined the staff of Messrs. Thomas L. Scott & Co., contracting engineers, 3, London Wall Buildings, London, E.C.

Mr. T. P. Miller has been appointed as electrical engineer by the Swinton and Pendlebury U.D.C. to superintend the laying of the E.L. mains, &c., by the Lancashire Electric Power Co., at a remuneration of 5 per cent. upon the cost price of the works carried out under his supervision.

Mr. Frank A. Blood has resigned his position in the designing switchboard engineers' department of the British Thomson-Houston Co., Ltd., Rugby, having been appointed assistant superintendent of outside switchboard construction with Messrs. Ferranti, Ltd., of Hollinwood.

On Wednesday, August 15th, Mr. W. E. Robson, chief draughtsman of the British Electric Plant Co., Alloa, was presented with a collection of works on electrical science and a card-indexing cabinet by the employés and staff, having accepted an appointment in the electrical engineering department of the Central Technical College, London.

Mr. Edmonds, wiring foreman and meter inspector for the Melton Mowbray E.L. Co., who is about to commence business in the town as a wiring contractor, has been presented by the staff and employés of the company with a timepiece.

It is reported that Mr. Marconi has associated himself with the Columbia Phonograph Co. as chief consulting physicist.

Mr. T. H. Saul has been appointed general clerk and commercial assistant in the offices of the Fulham Borough Council.

Obituary.—H. A. Moriarty, Captain R.N., C.B.—Captain Moriarty, who died on the 18th inst., at the age of 91 years, had a distinguished career, and took a prominent part in the early attempts to lay an Atlantic cable in 1857-8, and in 1865-6, his services in this connection being rewarded with the C.B. order. During the voyage of the *Great Eastern* in 1866 with the new cable, Captain Moriarty, as navigator, indicated the spot at which the end of the old broken cable should be found, having taken careful bearings of the position on the previous occasion, and his statement was exactly verified, the cable being hooked directly he announced that the ship was in the correct place. The cable was brought to the surface, but parted, and was finally secured a fortnight later.

Mr. Isaac Fitchen Cuttler, formerly manager of the St. Helens tramways, died at Southport on August 14th, at the age of 68 years. He was previously manager of the tramways at Accrington, Blackpool and Over Darwen.

Mr. C. O. Lloyd, of Turnham Green, electrical engineer, who died on June 19th, left estate of the gross value of £16,251, with net personalty £9,111.

We have to record with regret the death of Mr. James Dredge, C.M.G., of West Hill Park, Titchfield, Hants, which took place on Wednesday last week. Mr. Dredge, who was in his sixty-seventh year, was a pupil of Sir John Fowler, and had been joint editor of our esteemed contemporary *Engineering* for 36 years; he was known throughout the engineering world as an authority on matters connected with his profession, and had been prominently connected with many of the great exhibitions, in which he took a keen interest, his services in connection with their organisation and conduct being highly appreciated. Mr. Dredge was the recipient of many decorations from foreign governments; he was a member of the British Royal Commission at the Chicago Exhibition of 1893, and Commissioner-General for Great Britain at the Brussels Exhibition of 1897. He was a member of the Institutions of Civil and Mechanical Engineers, and was the author of many technical and other works.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Sir Hiram Maxim Electrical Co., Ltd. (84,426).—Issue on July 24th of £500, on July 25th of £500, on July 31st of £500, and on August 2nd of £500 debentures, part of series created May 16th, 1906, to secure £10,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series: £4,500.

Liverpool Silver and Copper Co., Ltd. (electrical process) (30,277).—Notice of the abandonment of the issue of £17,000 debentures dated January 9th and registered January 18th, 1906, as part of an authorised series of £20,000, has been filed. £12,000 4 per cent. first mortgage debentures, created and dated August 8th, 1906, have been registered. Property charged: The company's undertaking and property, present and future, including uncalled capital. No trustees.

Macartney, McElroy & Co., Ltd. (57,101).—This company's annual return was filed on August 9th, when 3,392 shares had been taken up out of a nominal capital of £60,000 in £10 shares. £10 per share has been called up on 3,312 and £33,120 has been received. £900 is considered as paid on 20 shares. Mortgages and charges: Nil.

Uxbridge and District Electric Supply Co., Ltd. (62,706).—Issue on August 10th of £1,600 6 per cent. second debentures, part of series created July 10th, 1906, to secure £15,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series: £6,200.

Baily, Grundy & Barrett, Ltd. (38,004).—This company's annual return was filed on July 12th, when 1,031 shares had been taken up out of a nominal capital of £10,000 in 2,000 shares of £5 each. £5 per share has been called up, and £5,155 has been received. Mortgages and charges: £3,000.

Ackroyd & Best, Ltd., lamp manufacturers, Morley (54,600).—Issue on July 25th of £1,000 debentures, part of series created March 3rd, 1904, to secure £15,000 at 10 per cent. interest with 2½ per cent. bonus, charged on the company's undertaking and property, present and future, including uncalled capital. Trustees: C. T. Naylor, Dean House, Kilmeston, Alresford, Hants; and J. P. Humble, Heaton Lodge, Wortley, Leeds. Previously issued of same series: £6,400.

Provincial Tramways Co., Ltd. (London) (6,445).—Issue on August 3rd of £15,000 4 per cent. debentures, part of series created May 27th, 1904, to secure £125,000. Property charged: The company's undertaking and assets, present and future. No trustees. Previously issued of same series: £106,500.

CITY NOTES.

Metropolitan District Railway Co.

The half-yearly meeting of this company was held on the 16th inst. at the Westminster Palace Hotel. We are indebted to the *Times* for particulars of the proceedings. Sir George Gibb, the chairman, who presided, referred to the completion of the equipment of the railway electrically and to the increased traffic and financial details mentioned in the company's report and recorded in our last issue. Sir George then touched on some engineering features. All the initial troubles and failures of the automatic signalling had been overcome; the new system increased the working capacity of the line, and he hoped it would prove an additional factor of safety. The cost of its maintenance under ordinary conditions would not be so high as it had been during the past half-year. As to the expenditure during the half-year on repairs and renewals of rolling stock, £23,643, he did not think it could be regarded as normal. They were now having very little trouble with the more important parts of the rolling stock, although there still remained some work to be done on the bogies. The motors and the controlling equipment had given no trouble from the commencement of working. The company had 198 motor-cars and 232 trailer cars, and the total cost of these worked out at about £30 per seat, which he considered was a reasonable price. The cost of electrical energy had been £65,543, or at the rate of 1·81d. per car-mile, exclusive of sub-stations. The supply of current had been admirably maintained, and there was reason to hope that its cost would be considerably reduced. Referring to the item of wages of trainmen for the six months, £22,127, he said that this figure included not only the motormen but also the car conductors and gatemen. The additional cost due to the employment of conductors and gatemen in the trains was at the rate of £20,000 a year, and this was a matter which was receiving careful consideration. The total expenditure, which included the whole cost of traffic operation and maintenance of rolling stock, was £104,889. The corresponding cost for the first half of the year 1899, when the railway was being worked by steam power, amounted to £63,426. In that half-year 624,383 passenger train-miles were run, whilst in the last half-year 1,196,112 miles were run, or an increase of 91·6 per cent. The cost with steam working was 24·38d. per train-mile, whilst the cost with electric working had been 21·05d. per train-mile, or a decrease of 3·33d. per train-mile. The company was now running 67 more trains each way over the railway each day, as compared with what it was doing in the year 1899. In regard to the revision of fares, the board had endeavoured to fix each fare with due regard to the circumstances affecting the traffic. According to the proposed revision, the fares from Hammersmith as far as West Kensington would be 1d., to Earl's Court 1½d., to Gloucester Road 2d., to South Kensington 2½d. Then from Sloane Square to Aldgate East all the stations would be grouped at a charge of 3d., which was practically adopting for all that group the existing single third-class fares. They intended to abandon the special reduction made in the return tickets. It was hoped to get the new fares into operation at the beginning of next month. He moved the adoption of the report, which was seconded by the Deputy-Chairman (Mr. Perks, M.P.).

A short discussion followed, in the course of which Mr. Darley asked for some particulars with regard to faulty rolling stock, and on whose shoulders the cost of repairs fell; and Mr. Manby inquired whether, in the event of the company being more prosperous, the arrears on the 4 per cent. guaranteed stock would be paid before the other shareholders received any dividend.

The Chairman, in reply, said the arrears of dividend would have to be paid before any dividend could be received by the holders of the other classes of stock.

An extraordinary general meeting followed, at which the Chairman moved a resolution authorising the company to create and issue £900,000 of second preference stock and £300,000 debenture stock under the Metropolitan District Railway Act, 1906. He said that the estimated capital expenditure for the next half-year was £80,000, and for the subsequent half-year £60,000, making a total of £140,000.

The Deputy-Chairman seconded the resolution, and it was carried.

Mexican Light and Power Co., Ltd.

The interim report of the company, which is reproduced at great length in the *Financial Times*, states that the gross earnings during the first six months of the present year were $1,754,833 and the operating expenses amounted to $722,330, of which $320,000 was due to the use of steam power; while the maintenance charges amounted to $111,772, all expressed in Mexican currency. There will be required to complete the work now in hand the sum of $1,000,000 in excess of the anticipated net earnings for the period ending December 31st, 1907. The net earnings from the first installation are estimated by the general manager to reach $190,000 gold per month in January, 1908; and should the demand for power continue to increase, the directors must consider the advisability of constructing a second hydraulic installation, with a capacity of about 40,000 H.P., which, by reason of the preliminary work already accomplished, should not cost more than $2,500,000 gold, and which, after providing for the fixed charges upon this capital expenditure, should ultimately ensure an increase of the net earnings of the company to more than $300,000 gold per month. The directors have not decided what securities they will advise the shareholders to issue to provide for future expenditure on capital account, but, in view of the satisfactory progress which has been made, they do not anticipate any difficulty in providing for the company's financial needs. At present, by using approximately 10 per cent. of steam power, chiefly on peak loads, the company is supplying a maximum of 20,000 H.P. daily. The installation in the Federal district totals 37,500 H.P., and the estimated annual increase in business is 6,000 H.P. In addition, the company has entered into a contract to supply electric power for the operation of the tramways of the Federal district for 10 years, commencing in October next with 5,000 H.P., which will increase to 7,500 H.P. as the existing tramway lines are extended. In June last a contract was made with the Federal Government to supply electrical energy for pumping potable waters for the city of Mexico for 20 years, which will require about 3,000 H.P. The mining camps at El Oro will require, in addition to the present actual supply, about 5,000 H.P. so soon as electrical equipments for its use can be installed by the mining companies. Many contracts for smaller units are under negotiation, which are only delayed by reason of the non-completion of the company's works, or by the time required by the consumers to obtain electrical equipment from the manufacturers. Originally formed with a view to providing a hydro-electrical plant at Necaxa, with transmission to and distribution within Mexico City of energy for power, &c., the company eventually absorbed the three then existing companies supplying electricity in the city. Owing to the unexpected opportunities for power supply which presented themselves, the Necaxa station was increased in size to contain six 8,200-H.P. turbines coupled to 5,000-KW. generators; transmission lines were completed to Mexico City (95 miles) and thence to El Oro (76 miles), a mining centre. With a view to safeguarding the company's water supply, a concession for rights over the upper water sheds in the area in question was obtained, and it is now estimated that 200,000 H.P. of electric power are available for production. The company owns several valuable franchises, including one covering the entire Federal district, an area of nearly 400 square miles, in which is situated the City of Mexico and 12 other municipalities. The towns of Guadalupe Hidalgo, Atzcapotzalco, Tacubaya, Mixcoac and San Angel are already supplied by the company, which is rapidly extending its field of operations to all the other important points in the Federal district, thus forming a complete system of distributing wires, which will guarantee its effective control of the entire Federal district. This Federal concession extends till the year A.D. 2012.

North Metropolitan Tramways.

At the half-yearly meeting of this company, the Chairman, in moving the adoption of the report, said the only prominent figure in the accounts was the item of £83,358, chiefly composed of the amount received from the London County Council in respect of the four years' profit for the unexpired portion of the lease. After deducting debenture interest and loss on investments there was a balance of £76,257, and of this the directors proposed to appropriate £72,099 as a dividend to the shareholders at the rate of 13s. per share on the ordinary shares, less tax. The proprietors must regard this as part payment of the amount of £4 or £5 per share, which he said he thought he should be able to announce at that meeting. An application had been made to the Court for a reduction of the share capital of the company and for the return of £3 10s. per share, but it had been ordered to stand over until next October. The company had to go to arbitration in the matter of East Ham and the Barking Road depôt, and as money was realised it would be paid over to the shareholders without delay. The money for the £3 10s. per share was lying in the bank, but the directors could not distribute it without the order of the Court.—*Financial Times.*

Dublin and Lucan Electric Railway Co.—At the half-yearly meeting held on 16th inst., the chairman attributed the decreased receipts compared with the corresponding period of last year to the dullness of trade. The sum now available for dividend, after payment of debenture interest, was £875 3s. 3d., which it was agreed to apply as follows:—£475 in payment of the half-year's dividend on the 5 per cent. preference shares; £100 on account of the electrical contractor's debt; to write £100 off the price (£428) of a recently purchased new electric motor; and to carry forward the balance of £208 3s. 3d. to the next half-year.

Oxford Electrical Co., Ltd.—An interim dividend on the ordinary shares at the rate of 5 per cent. per annum for the half-year ended June 30th, has been declared.

Crossley Bros., Ltd.—The directors have declared an interim dividend of 10 per cent.

Oldham, Ashton and Hyde Electric Tramway Co.—This company announces an interim dividend at the rate of 5 per cent. per annum.

Toronto Electric Light Co.—The accounts for the six months ending June 30th last, show, after paying the dividend, a surplus of $78,610, as compared with $42,175 in 1905.

The Chilian Electric Tramways and Light Co.—This company shows a net profit of £173,246 for 1905, as compared with £88,670 for 1904. A dividend of 9 per cent. has been declared on £1,694,000, as against 8 per cent. on £950,000 in 1904.

Stock Exchange Notices.—Application has been made to the Committee to appoint a special settling day in and to grant a quotation to:—

South Metropolitan Electric Tramways and Lighting Co., Ltd.—Provisional certificates (fully and partly paid) for 150,000 6 per cent. cumulative preference shares of £1 each, and £150,000 4 per cent. debenture stock.

And to allow the following security to be quoted in the Official List:—

Folkestone Electricity Supply Co., Ltd.—Further issue of £15,000 4½ per cent. first debenture stock.

Northern Counties Electric Supply Co., Ltd.—The agreement for the sale of the above company to the Cleveland and Durham Electric Power Co., Ltd., on the basis of 25s. for each 20s. share, has been completed. The cash payments will not be made until October 1st, but they will bear interest at the rate of 3 per cent. from July 1st. The exchange of shares will be made in the middle of next month.

Chloride Electrical Storage Co., Ltd.—The annual general meeting was held at the works, Clifton Junction, near Manchester, on 15th inst., Mr. W. Bannister, J.P., presiding. Mr. W. Bannister proposed, and Dr. Hopkinson seconded, the adoption of the directors' report and statement of accounts, to which we referred briefly in our issue of August 10th. The profit for the 12 months ending June 30th last was £24,702, and during the year the debentures, amounting to £20,000, having matured, were entirely paid off. Dividends of 6 per cent. on the Preference and of 10 per cent. on the ordinary shares were declared, the dividend on the ordinary being an advance of 2 per cent. on previous years. £8,000 was carried to reserve fund. The report was adopted.

German Transatlantic Electricity Co.—The report for 1905 states that the share capital was increased by £700,000 to £1,800,000 for the purpose of providing for the rapid development of the company's enterprises, and it is now proposed to make a fresh issue, which will bring the total capital up to £3,600,000. The company recently acquired the sub-station of the Buenos Ayres Electric Tramways Co., and made an agreement with that company for the supply of energy for the whole period of the concession. The company leased from La Capital Tramway Co. its central station and plant of 2,075 H.P. in return for an annual payment of £5,000. On the other hand, the company leased to the Grand National Co. the Metropolitan Co. for a yearly payment of £20,000 and two-thirds of the receipts in excess of a total of £22,500. The company also made arrangements with the Grand National groups to supply energy for all the lines. A contract was also made with the Cia. Belga-Argentina de Tramways for the supply of energy.—*Review of the River Plate.*

South Wales Electrical Power Distribution Co.—An extraordinary general meeting of the proprietors of the company was held on August 8th, at Cardiff, when it was agreed to create and issue £500,000 debenture stock bearing interest at the rate of £5 per cent. per annum; also £1,000,000 of new share capital in 100,000 £10 preference shares with interest as above.

Bolckow, Vaughan & Co., Ltd.—After providing for depreciation, the accounts of this company show a profit, including £45,224 brought forward, of £389,359. Expenditure upon new collieries, machinery, &c., during the year has been £247,919, of which £191,219 has been debited to capital account. It is proposed to write off capital account, in addition to the £56,700 from revenue, a further £50,000, to pay a dividend of 6 per cent. on the ordinary shares, and to carry forward £80,925.—*Financial Times.*

Mather & Platt, Ltd.—The report for the year ended June 30th last, to be presented at the meeting at Manchester on the 29th inst., states that the net profits for the year, after charging depreciation and making provision for directors' remuneration and expenses, are £103,868, which with the balance brought forward, £21,239, makes an available total of £125,107. The directors recommend a dividend at the rate of 7 per cent. per annum on the ordinary shares for the year (less interim dividend paid in March) and a bonus of 3 per cent., transferring to reserve account (bringing up the amount to £270,000) £40,000 and carrying forward £25,107. The directors have for some time had under consideration the question of a change in the period of the annual stocktaking, and have come to the conclusion that it is desirable to alter the date from June 30th to December 31st. The next balance-sheet will accordingly be made up to the end of December, 1906, with a view to the payment of dividends on March 1st following. The interim dividends will thus in future years fall to be paid in September instead of March.—*Financial Times.*

MARKET QUOTATIONS.

Wednesday, August 22nd.

CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal)	per ton	£38 10	..
a ,, ,,	per ton	£30	..
a Bleaching powder	per ton	£5 10	..
a Bisulphide of Carbon	per ton	£18	..
a Borax	per ton	£15	..
a Benzole (90 %)	per gal.	10½d.	..
a ,, (50 %)	per gal.	10d.	..
a Copper Sulphate	per ton	£26	..
a Lead, Nitrate	per ton	£28	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90 % at 160° C)	per gal.	5/6	..
a Potassium Bichromate, in casks	per lb.	3½d.	..
a Potash, Caustic (75/80 %)	per ton	£20	..
a Potassium Cyanide	per lb.	7½d.	..
a Shellac	per cwt.	200/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers	per ton	£6 10	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %)	per ton	£10 15	..
a ,, Crystals	per ton	£3 5	..
a Sodium Bichromate, casks	per lb.	2¾d.	..
a ,, Cyanide	per lb.	7d.	..
METALS, &c.			
b Aluminium Ingots, in ton lots	per ton	£200	..
b ,, Wire, in ton lots	per ton	£220	..
b ,, Sheet, in ton lots	per ton	£210	..
b Babbitt's metal ingots	per ton	£48 to £140	..
c Brass (rolled metal 2" to 12") basis	per lb.	9d.	..
c ,, Tube (brazed)	per lb.	10½d.	..
c ,, ,, (solid drawn)	per lb.	9½d.	..
c ,, Wire, basis	per lb.	9½d.	..
c Copper Tubes (brazed)	per lb.	1/-	..
c ,, ,, (solid drawn)	per lb.	1/-	..
g Copper Bars (best selected)	per ton	£97	..
g Copper Sheet	per ton	£97	..
g ,, Rod	per ton	£97	..
c ,, (Electrolytic) Bars	per ton	£92	..
c ,, ,, Sheets	per ton	£104	..
c ,, ,, Rod	per ton	£95	..
c ,, ,, H.C. Wire	per lb.	11d.	..
f Ebonite Rod	per lb.	8/8	..
,, Sheet	per lb.	8/-	..
n German Silver Wire	per lb.	1/7	..
h Gutta-percha, fine	per lb.	6/- to 7/-	..
h India-rubber, Para fine	per lb.	5/2 to 5/2½	..
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	53/7½	1/7½ inc.
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8	per ton	£9 15	..
g Lead, English Ingot	per ton	£17 7 6 to £17 10	7/6 to 10/- in.
g ,, ,, Sheet	per ton	£19 7 6 to £19 10	7/6 to 10/- in.
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£7	..
d Mica (in original cases) small	per lb.	6d. to 1/-	..
d ,, ,, ,, medium	per lb.	2/6 to 4/-	..
d ,, ,, ,, large	per lb.	4/6 to 8/6	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/3	..
p ,, rolled bars & rods	per lb.	1/1½ to 1/3	..
p ,, ,, strip & sheet	per lb.	1/4	..
c Platinum	per oz.	nominal	..
e Silicium Bronze Wire	per lb.	1/- to 1/1	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
,, ,, in bars		£15 to £40	..
g Tin, Block (English)	per ton	£183 to £184	50/- inc.
n ,, Wire, Nos. 1 to 16	per lb.	2/2	..
p White Anti-friction Metals— "White Ant" brand	per ton	£45 to £70	..
h Zinc, Sh't's (Vieille Montagne bnd.)	per ton	£33	..

Quotations supplied by:—

a G. Boor & Co.
b The British Aluminium Co., Ltd.
c Thos. Bolton & Sons, Ltd.
d F. Wiggins & Sons.
e Frederick Smith & Co.
f India-Rubber, G.P. and Telg. Works Co., Ltd.
g James & Shakspeare.
h Edward Till & Co.
i Bolling & Lowe.
k Morris Ashby, Ltd.
m W. T. Glover & Co., Ltd.
n P. Ormiston & Sons.
o Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Co., Ltd.

Railway Accidents During 1905.—The Board of Trade report on the accidents that occurred on the railways of the United Kingdom during the year 1905 shows that 1,099 persons were killed and 6,459 were injured by accidents due to the running of trains or the movement of railway vehicles. The average figures for the previous nine years were 1,149 and 6,651 respectively. The year was remarkable for the number of fatalities to passengers in train accidents, but 38 out of a total of 39 deaths of passengers were due to four collisions and derailments of trains. The number of passengers injured in train accidents was much below the average. The numbers of railway servants killed and injured in train accidents were six and 112 respectively, figures also far below the average of previous years.

STOCKS AND SHARES.

Tuesday Evening.

August activity in the Stock Exchange is far too uncommon for it to be regarded as anything but a happy omen of increased business when the world and his wife shall return from their holidays. Markets are energetic in many directions. An American "boom" ran neck-and-neck with a revival in Kaffirs, while other departments felt the sustaining force of sympathy. Against this must be set the terrible calamity at Valparaiso, to which is partly due the continued slackness in the prices of Consols and Home Railway stocks. Investment issues are rather throwing off allegiance to Consols, and, as the following price-lists show, electrical descriptions move upon their own lines.

Railway stocks demand the first attention. Coming soon after Lord Stalbridge's announcement with reference to an electrified London and North-Western line between Euston and Watford, there has been another, by Sir Ernest Paget, stating that the Midland will shortly adopt similar means of traction between Lancaster and Morecambe. In time, no doubt, we shall see even the Great Eastern seriously dealing with the electrification of some of its suburban services: the Company talked much, some years ago, of what it might do in this direction, but has remained passive whilst most of the other important Railways have grappled actively with the problems connected with it.

Central London Ordinary and Preferred stocks are both two points down, *ex* 2 per cent. dividend, and City and South London has not yet recovered the amount of the distribution deducted last week. Great Northern and City Preferred shares are ¼ better at 3¾, but the most noticeable movement is the advance to 24 in Districts. The Chairman declared that the company would have to raise its fares, and upon the strength of this Districts have been bought by a few speculators. Such a step will probably bring the Metropolitan Railway into line with it, and even the beneficiaries of the chief rates can scarcely complain if they are called upon to pay a little more than fourpence for a return ticket from Hammersmith to Bishopsgate or Aldgate.

Chili's fearful disaster has moved but one price in any of the markets with which we deal, Chili Telephones falling a sovereign to 6¾. Anglo-American Telegraph "A" is a point better, but in sympathy with the advance in American Railways rather than from hopes of an increase of traffic on account of the earthquake. In the Eastern group there are two rises, both of ½ per cent., in the Preference and Debenture stocks of the Eastern Telegraph Company. No other changes call for comment.

National Telephone Preferred and Deferred are again side by side at 109, showing advances of ½ and 1 respectively.

Several electricity supply companies' shares participated in *ex* dividend markings last pay day, but without producing material alterations in prices; Charing Cross Ordinary and Preference and Metropolitan Ordinary were unchanged, notwithstanding their dividend deductions. The needlessly wide margins officially quoted between buying and selling prices do not permit of much variation occurring when dividends are half-a-crown, as in the case of Charing Cross Ordinary, or 2s. 3d., like that of the Preference. Westminster Ordinary are *ex* 5s. 6d., but the price was only put down ⅛, to 10. Edmundson's Preference at 5¼ are the fraction up, and a few Debenture stocks are a point better. Rises of ¼ have occurred in City of London and County of London Ordinary shares, and County Preference are up 10s.

Business in traction varieties is quiet, with no feature of importance beyond improvements of 5s. in British Electric Ordinary and 10s. in the Preference. London Motor Omnibus shares are duller at 1 1/16, while London General Omnibus stock stands about 90. London United Tramways Preference are ½ to the good at 8⅝, but the Debenture is down a trifle. Buenos Ayres and Belgrano Ordinary have retrograded 1/16 upon further consideration of the report, which document, by the way, has been the subject of spirited comment in the Stock Exchange, some reading it as very satisfactory, and others taking a less rosy view of it. But Anglo-Argentine trams, old and new, are both better, and Cape Electrics took advantage of the rise in Kaffir shares to improve to 15s.

Manufacturing shares are so quiet that it could be truthfully said there were no alterations, but for a few issues from whose prices the dividends have just been deducted.

Gas.—Prof. Church has charged the gas companies with being "the chief destructive agency at work on pictorial and other artistic productions" in London generally, and the Palace of Westminster in particular.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last four years, 1902.	1903.	1904.	1905.	Closing Quotations Aug. 14th.	Closing Quotations Aug 21st.	Business done week ended Aug 21st, 1906. Highest	Lowest.	Rise + or Fall —
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	..	8¼ — 4	8¼ — 4	..	..	..
155,600£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	Nil	Nil	Nil	5 %	87 — 92	87 — 92	89½	89½	..
702,600	Anglo-American Telegraph	Stock	60/6	61s.	23%	3½%	66 — 68 xd	66 — 68	66	..	..
3,148,700	Do. do. do. 6 % Pref.	Stock	6 %	6 %	5%	6 %	113½—114½ xd	114 —115	114½	113½	+ ½
3,148,700	Do. do. do. Deferred	Stock	1/-	2s.	Nil	½%	22½ — 22¾	24½— 24½	24½	22½	+1½
50,000	Anglo-Portuguese Tel., 5% Mort. Deb. Stock Red.	100	..	..	..	..	101 —103	101 —103	..	..	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	6 %	7 %	8 %	8 %	7⅜ — 7⅝	6¼ — 7	..	..	—¼
1,982,856£	Commercial Cable Stlng. 500 year 4 % Deb. Sk. Red.	Stock	4 %	4 %	4 %	4 %	97½ — 99½	97½ — 99½	98½	..	..
16,000	Cuba Telegraph	10	6¾%	10 %	5 %	5 %	8½ — 9	8½ — 9	..	..	..
6,000	Do. 10 % Pref.	10	10 %	5 %	10 %	10 %	17 — 18	17 — 18	..	..	..
12,981	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	4 %	8⅜ — 8⅝	8⅜ — 8⅝	..	..	..
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 %	8½ — 9½	8½ — 9½	..	..	..
30,000	Do. do. 4½ % Debs.	50	4½%	4½%	4½%	4½%	98 —101	98 —101	..	..	..
60,710£	Direct United States Cable	20	3½%	3 %	3½%	4½%	15½ — 16	15½ — 16	15⅞	15⅝	..
65,500	Direct W. India Cable, 4½ % Reg. Deb., 1 to 1,900, R.	100	4½%	4½%	4½%	4½%	100 —102	100 —102	..	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	7 %	144 —147	144 —147	146	144½	..
2,000,000	Do. 8½ % Pref. Stock	100	8½%	8½%	8½%	8½%	8⅜ — 9⅛	90 — 92	91½	91½	+ ⅜
1,848,772	Do. 4 % Mort. Deb. Stock Red. ..	Stock	4 %	4 %	4 %	4 %	106⅝—108½	107 —109	107½	..	+ ⅜
800,000	Eastern Extension, Australasia, and China Tele.	10	7 %	7 %	7 %	7 %	14½ — 14⅝	14½ — 14⅝	14⅝	14⅝	..
752,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	105 —107 xd	105 —107 ..	..	..	..
200,000	East & S. Afric. Tel., 4 % Mt. Deb., 1 to 5,000, red. 1909	100	4 %	4 %	4 %	4 %	99 —101 xd	99 —101	..	..	..
200,000£	Do. 4 % Reg. M. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	4 %	100 —102	100 —102	..	..	..
180,887	Globe Telegraph and Trust	10	£8	5⅝%	5⅝%	5½%	10½ — 11 xd	10⅝ — 11	10½	10⅜	..
180,887	Do. do. 6 % Pref.	10	6 %	6 %	6 %	6 %	14½ — 14⅝ xd	14½ — 14⅝	14½	14½	..
150,000	Great Northern Telegraph, of Copenhagen ..	10	12½%	15 %	24 %	24%	38 — 40	37½ — 39½	38½	..	— ½
37,900	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,900, Red.	100	4½%	4½%	4½%	4½%	100 —102	100 —102	..	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	18 %	13 %	58 — 60	58 — 60	..	..	..
261,127	Marconi's Wireless Telegraph	1	Nil	Nil	Nil	Nil	1⅝— 1⅞	1⅝— 1⅞	..	..	..
72,680	Monte Video Telephone Co., Ltd. Ord.	1	3 %	3 %	4 %	..	⅞ — 1	⅞ — 1	..	..	— 1/16
86,492	Do. do. do. 5 % Pref. ..	1	5 %	5 %	5 %	..	1⅛ — 1	1⅛ — 1⅛	..	..	+ 1/16
1,983,333	National Telephone, Pref. Stock	100	6 %	6 %	6 %	6 %	107½ —109½	108 —110	108½	108½	+ ½
1,966,667	Do. do. Def. Stock	100	4½%	5 %	5 %	5 %	107 —109	108 —110	109½	107½	+1
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	6 %	11 — 13	11 — 13	..	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	6 %	10½ — 12½ xd	10½ — 12½	..	..	..
250,000	Do. do. 5 % Non-cum. 3rd P., 1 to 250,000	5	5 %	5 %	5 %	5 %	5½ — 5⅞ xd	5½ — 5⅞	..	..	..
2,000,000	Do. do. 3½ % Deb. Stock Red. ..	Stock	3½%	3½%	3½%	3½%	97 — 99	97½ — 99½	99	97½	+ ½
1,689,598	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	102 —104	102 —104	103½	..	..
179,318	Oriental Telep. and Elec. 1 to 171,504, fully paid	1	6 %	6½%	6½%	7½%	1 5/16— 1 7/16	1 5/16— 1 7/16	..	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	6 %	6 %	6 %	6 %	1 5/16— 1 7/16	1 5/16— 1 7/16	..	..	..
100,000	Do. do. do. 4% Red. Deb. Stock	100	..	..	..	4 %	97 — 99	97 — 99	..	..	..
100,000	Pacific & European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	4 %	99 —102	99 —102	..	..	..
11,889£	Reuter's	8	5 %	5 %	5 %	5 %	7½ — 7⅝	7½ — 7⅝	7⅝	..	..
60,000	Telephone Co. of Egypt, 4½ % Deb. Red. ..	100	..	..	..	4½%	101 —104	101 —104	..	..	..
3,201	Submarine Cables Trust	Cert.	6 %	6 %	6 %	6 %	129 —132	129 —132	..	..	..
70,000	United River Plate Telephone	5	7 %	8 %	8 %	8 %	7 — 7½	7 — 7½	7 5/16	..	..
40,000	Do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	5 %	5 %	5½ — 5¾	5½ — 5¾	..	..	..
179,947	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	5 %	109 —112	109 —112	..	..	..
15,609£	West African Telegraph, Shares	10	2 %	4 %	4½%	4 %	9½ — 10	9½ — 10	..	..	..
80,000	W. Coast of America, 1 to 80,000 & 53,001 to 53,006	2½	Nil	Nil	Nil	Nil	3/16 — 7/16	3/16 — 7/16	..	..	..
150,000	Do. 4 % Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	4 %	4 %	4 %	4 %	100⅜ —103½	100⅜ —103½	..	..	..
507,980	Western Telegraph, Ltd., Nos. 1 to 307,980 ..	10	7 %	7 %	7 %	5 %	14½ — 14⅝	14½ — 14⅝	..	..	..
75,000	Do. do. 5 % Debs. 2nd series, 1906	100	5 %	5 %	5 %	5 %	.. ..	.. ..	..	..	..
668,980	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	103 —106	103 —106	..	..	..
88,321	West India and Panama Telegraph	10	Nil	Nil	Nil	..	⅜ — ½	9/3	..	..	..
84,569	Do. do. 6 % Cum. 1st Pref.	10	7 %*	7 %*	6 %	5 %	6⅞ — 6⅞	6½ — 6⅝	6 5/16	..	..
4,669	Do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	Nil	Nil	4½ — 5⅛	4½ — 5⅛	..	..	..
80,000£	Do. do. 5 % Debs., Nos. 1 to 1,800 ..	100	5 %	5 %	5 %	5 %	99 —102	99 —102	..	..	..

Including arrears.

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

170,000	Anglo-Argentine Trams. 250,001 to 420,000 ..	5	..	..	0 %	5 %	6½— 7 1/16	7 — 7½	7 3/32	6½	+ 1/16
100,000	Do. Nos. 430,008 to 910,007 and 560,008 to 580,007 ..	5	..	..	..	..	6½ — 6⅝	6⅝ — 7	6⅝	6⅝	+ ⅛
260,007	Do. 5½ % Cum. Prefs., 1 to 260,007 ..	5	..	5 %	5 %	5½%	5½ — 6	5⅝ — 6	5⅝	5⅛	..
266,600	Do. Permanent, 6 % Deb. Stock, 1888	100	..	6 %	6 %	6 %	138 —141	138 —141	..	..	..
285,100	Auckland E. Trams., 5 % 1st Mort. Deb. Stock ..	100	..	5 %	5 %	5 %	102 —104	102 —104	103½	..	..
800,000	Babcock & Wilcox, 1 to 580,000	1	..	17 %	20 %	20 %	3⅞ — 4⅛	3⅞ — 4⅛	82/6	80/7½	..
100,000	Do. do. 6 % Cum. Pref., 1 to 100,000 ..	1	..	6 %	6 %	6 %	1⅛ — 1⅜	1⅛ — 1⅜	..	..	..
88,000	British Aluminium, Ord., 2,001 to 40,000	5	..	..	7 %	7 %	3⅞ — 4	3⅞ — 4	79/4½	77/6	..
40,000	Do. do. 7 % Cum. Pref...	5	Nil	Nil	7 %	7 %	6 — 6½	6 — 6½	6½	..	..
20,000	Do. do. "A" 6 % Cum. Pref.	5	Nil	Nil	6 %	6 %	5 — 5½	5 — 5½	5⅜	..	..
20,000	Do. do. 4 % Funding Certs.	5	..	..	4 %	4 %	4 — 4½	4 — 4½	..	..	..
800,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	5 %	101 —105	101 —105	100	..	..
800,000	British Columbia E. Rail Def. Ord. Stock	100	..	6 %	6 %	6 %	117 —120	117 —120	118¾	..	..
800,000	Do. 5 % Pref. Ord. Stock	100	..	5 %	5 %	5 %	108 —111	108 —111	111	..	..
115,000	Do. 5 % Cum. Perp. Pref. Stock	100	..	5 %	5 %	5 %	105 —108	105 —108	107½	106¾	..
240,400	Do. 4½ % 1st Mort. Debs., 1 to 6,250	40	..	4½%	4½%	4½%	103 —105	103 —105	..	..	..
220,000	Do. 4½ % Vancouver Power Debs., 1 to 2,200	100	..	4½%	4½%	4½%	101 —104	101 —104	..	..	..
133,801	British Electric Traction	10	8 %	6 %	6 %	3 %	5¼ — 5⅝	5½ — 6	5⅞	5⅜	+ ⅛
161,497	Do. do. 6 % Cum. Pref.	10	6 %	6 %	6 %	6 %‖	9 — 9½	9½ — 9⅞ xd	9 5/16	8¾	..
1,415,422£	Do. do. 5 % Perp. Deb. Stock ..	Stock	5 %	5 %	5 %	5 %	111 —114	112 —115	114	113½	..
410,178	Do. do. 4½ % 2nd Deb. Stock Red.	100	..	..	4½%	4½%	90 — 93	90 — 93	..	..	+1
100,000	British Insulated and Helsby Cables	5	10 %	8 %	8 %	8 %	6⅞ — 7⅛	6⅞ — 7⅛	6⅞	..	..
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 %	5¾ — 6	5¾ — 6	..	..	..
500,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	4½%	4½%	4½%	4½%	102 —105	102 —105	..	..	..
212,000	British Thomson-Houston 4½ % 1st Mort. Debs. ..	100	..	4½%	4½%	4½%	83 — 88	96 — 98	..	..	..
400,000	British Westinghouse 6 % Pref., 1 to 200,000 and 275,001 to 475,000	5	..	6 %	Nil	..	1¼ — 1⅜	1¼ — 1⅜	..	..	..
1,016,358	Do. do. 4 % Mort. Deb. Stock ..	100	..	4 %	4 %	4 %	77 — 83	77 — 83	..	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	..	11/- — 11/3	11/- — 11/3	..	..	..
50,000	¶ Do. do. 6 % Cum. Pref. ..	£1	Nil	Nil	Nil	..	14/6 to 15/6	14/6 to 15/6	..	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731 ..	2	Nil	Nil	Nil	2½%	2 — 1 7/8	2 — 1 7/8	..	..	..
150,000	Do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	6 %	1½ — 1⅝	1½ — 1⅝	33/9	..	..
125,000£	Do. 4½ % Perp. Deb. Stock ..	Stock	4½%	4½%	4½%	4½%	97 — 99	97 — 99	..	..	..
125,000£	Do. 4½ % Perp. 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	82 — 84	82 — 84	..	..	..
100,000	Buenos Ayres & Belgrano, 1 to 100,000	5	..	3 %	4 %	3 %	3 5/16— 3 7/16	3⅜ — 3⅝	80/-	70/-	— 3/16
40,000	Do. "A" 6 % Cum. Pref., 1 to 40,000	5	..	6 %	6 %	6 %	5¼ — 5⅜	5¼ — 5⅜	5⅜	..	..
27,500	Do "B" do. 1 to 27,500	5	..	6 %	6 %	6 %	5 — 5⅛	5 — 5⅛	..	..	..
317,700	Do. 5 % Deb. Stock	100	..	5 %	5 %	5 %	104 —106	104 —106	..	..	..
190,000	Do. 5 % 2nd Deb. Stock	100	..	5 %	5 %	5 %	102 —105	102 —106	..	..	..
105,000	Calcutta Trams., 1 to 105,000	5	..	6 %	8 %	8 %	8 — 8¼	8 — 8⅛	8⅛	8 1/16	..
32,610	Do. 105,001 to 137,610	5	..	..	..	8 %	7¾ — 8⅛	7¾ — 8⅛	8 1/16	..	..
350,000	Do. 4½ % 1st Deb. Stock	100	..	4½%	4½%	4½%	103 —106	103 —106	104½	..	..
35,000	Callender's Cable Construction shares	5	15 %	12½%	12½%	15%	10¾ — 11¼	10¾ — 11¼	..	..	..
40,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5⅜ — 5¾	5⅜ — 5¾	..	..	..
300,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	108 —110	108 —110	109½	..	..
491,222	Cape E. Trams., 1 to 491,222	1	..	15 %	10 %	5 %‖	2 1/16— 1 1/8	⅞ — 1	..	..	— 1/16
450,000	Castner-Kellner Alkali, 1 to 450,000	1	..	4 %	4 %	6 %	1 3/32— 1 1/8	1 3/32— 1 1/8	..	..	..
230,211	Do. do. 4½ % 1st Mort. Deb. Stock	100	..	4½%	4½%	4½%	95 —100	95 —100	..	..	..
1,939,698	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	4 %	87 — 89	85 — 87 xd	86⅜	85½	..
930,816	Do. do. 4 % Pref. Stock ..	Stock	4 %	4 %	4 %	4 %	99 —101	97 — 99 xd	98⅜	..	..
930,816	Do. do. Def. do.	Stock	4 %	4 %	4 %	4 %	73 — 76	73 — 76	75	74⅜	..
430,000	City and South London Railway	Stock	3½%	2½%	3½%	1¾%	45 — 47	44 — 46 xd	46	43⅝	..
85,000	Crompton & Co., Nos. 1 to 85,000	8	5 %	2½%	2½%	2½%	1¾ — 2	1¾ — 1⅞ xd	..	..	..
10 ,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £160, and 901 to 11,000 of £80 Red.	..	5 %	5 %	5 %	5 %	95 — 98	95 — 98	..	..	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § Interim dividends.
‖ And bonus of 10s. ¶ From Manchester Share List.

(Continued on next page.)

SHARE LIST OF ELECTRICAL COMPANIES.—*(Continued)*

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.—*(continued).*

Present Issue.	NAME.	Stock or Share.	Dividends for the last four years. 1902.	1903.	1904.	1905.	Closing Quotations Aug. 14th.	Closing Quotations Aug. 21st.	Business done week ended Aug. 21st, 1906. Highest	Lowest.	Rise + or Fall—
260,000	Dick, Kerr & Co., 1 to 260,000	£1	..	..	10 %	..	1¼ — 1⅜	1¼ — 1⅜	25/-	..	..
305,000	Do. do. 6 % Cum. Pref., 1 to 305,000	£1	..	6 %	6 %	6 %	1⅜ — 1⅝	1⅜ — 1⅝	..	..	..
294,150	Do. do. 4½ % Deb. Stock	£100	..	4½ %	4½ %	4½ %	103 —106	103 —106	..	..	+ ½
60,000	Dublin United Trams. (1896), 1 to 60,000	£10	..	5¼ %	6 %	6 %	14 — 15	14½ — 15½	..	..	..
59,987	Do. 6 % Pref. between 1 and 60,000	£10	..	6 %	6 %	6 %	14 — 15	14 — 15	..	..	..
300,000	Do. 3½ % "A" Debs.	£100	..	3½ %	3½ %	3½ %	98¼ — 99	98½ — 99	..	..	..
300,000	Do. 3½ % "B" Deb. Stock	£100	..	3½ %	3½ %	3½ %	95⅝ — 96	95⅝ — 96½	..	..	— ⅛
99,261	Edison & Swan Utd., "A" shrs., £3 pd., 1 to 99,261	£5	Nil	Nil	1½ % §	..	1⅝ — 1⅞	1⅝ — 1⅞	33/9	31/6	..
17,189	Do. "A" shares, 01—017,189	£5	Nil	Nil	2½ % §	..	2⅜ — 2⅝	2⅜ — 2½	52/6	..	..
344,023‡	Do. 4 % Deb. Stock Red.	£100	4 %	4 %	4 %	4 %	85 — 87	85 — 87	..	..	..
100,000‡	Do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	£100	6 %	6 %	5 %	5 %	90 — 95	90 — 95	..	..	..
112,100	Electric Construction 1 to 112,100	£2	6 %	4 %	Nil	Nil	⅛ — ¼	⅛ — ¼	6/-	..	..
31,890	Do. do. 7 % Cum. Pref., 1 to 31,890	£2	7 %	7 %	7 %	7 %	1⅝ — 2⅛	1⅝ — 2⅛	..	..	..
200,000	Do. do. 4 % Perp. 1st Mort. Deb. Stk.	Stock	4 %	4 %	4 %	4 %	86 — 89	86 — 89	..	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	£10	5 %	5 %	5 %	5 %	9 — 9½	9 — 9½	..	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	4 %	4 %	4 %	4 %	93 — 97	93 — 97	..	..	..
78,000	Gt. N. & City Rail Pref. Ord. "A" 4 % 1 to 78,000	£10	..	3 %	4 %	4 %	3½ — 3⅝	3½ — 3⅝	70/-	..	..
96,000	Greenwood & Batley 7 % Cum. Pref.	£10	..	7 %	7 %	7 %	10½ — 10¾	10½ — 10¾	..	..	..
80,000	Do. do. 5 % Mort. Debs.	£100	..	5 %	5 %	5 %	101 —103	100 —102	..	..	—1
200,000	Henley's (W. T.), Telegraph Works, Ord.	£5	20 %	15 %	15 %	15%	12 — 13	12 — 13	12¾	..	..
200,000	Do. do. 4½ % Pref.	£5	4½%	4½%	4½%	4½%	5⅜ — 5⅝	5⅜ — 5⅝	..	..	..
41,978	Do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	4½%	107 —109	107 —109	..	..	..
108,022	Do. do. Scrip. All paid	..	..	..	..	..	107 —109	107 —109	..	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works.	£10	10 %	10%	5 %	10%	17 — 18	17 — 18	17⅞	17½	..
37,500	‡Liverpool Overhead Railway, Ord.	£10	1½%	1½%	1½%	Nil	1 — 1⅛	1 7/16 — 1 7/8	..	..	+ 3/16
10,000	‡ Do. do. Pref. £10 paid	£10	5 %	5 %	5 %	5 %	4½ — 6½	4½ — 6½	..	..	— ¼
600,070	London United Trams (1901), 1 to 50,007	£10	..	8 %	6 %	3 %	8 — 8½	8 — 8½	..	..	..
399,930	Do. do. 50,008 to 100,000 (£6 paid)	£10	..	8 %	6 %	3 %	8½ — 4½	4 — 5	..	..	+ ½
125,000	Do. do. 5 % Cum. Pref., 1 to 125,000	£10	..	5 %	5 %	5 %	8½ — 8⅝	8⅝ — 8⅞ xd	8⅝	..	+ ⅛
1,331,000	Do. do. 4 % 1st Mort. Deb. Stock	£100	..	4 %	4 %	4 %	93½ — 96½	93 — 96	94½	..	— ½
314,016	Metropolitan Electric Trams, Defd.	£1	Nil	Nil	Nil	3 %	½ — ½	½ — ½	2/6	..	..
600,000	Do. 5 % Cum. Pref.	£1	5 %	5 %	5 %	5 %	1⅜ — 1⅝	1⅜ — 1⅝xd	16/3	..	..
350,000	Do. 4½ % Deb. Stock Red.	£100	..	..	4½ %	4½ %	100 —102	100 —102	..	..	..
20,000	Peebles (B.) & Co. 6 % Cum. Pref., 20,001 to 40,000	£5	..	..	6 %	6 %	4⅞ — 5⅛	4⅞ — 5⅛	..	..	..
24,500	Potteries E. Trc., 20,001 to 40,000 & 50,001 to 54,500	£10	..	5 %	5 %	4 %	6⅝ — 7¼	6⅝ — 7¼	..	..	..
24,500	Do. 5 % Cum. Pref., 1 to 20,000 & 40,001 to 44,500	£10	..	5 %	5 %	5 %	7⅞ — 8¼	7⅞ — 8⅛ xd	7⅞	..	..
245,000	Do. 4½ % Deb. Stock	£100	..	4½%	4½%	4½%	100 —103	100 —103	..	..	..
37,350	Telegraph Construction and Maintenance	£2	20 %	20 %	15 %	15 %	33 — 35	33¼ — 35½	35	33½	+
150,000‡	Do. 4 % Deb. Bds., 1 to 1,500 Red. 1909	£100	4 %	4 %	4 %	4 %	100 —102	100 —102	100½	..	..
3,599,300	Undergd. E. R., Lon., 5 % Profit Shar. S. Nts.	..	..	..	5 %	5 %	90 — 92	90 — 92	90	..	..
540,000	Waterloo & City Railway, Ord. Stock	£100	5½%	5½%	3½%	3½%	102 —105	101 —104	..	..	—1
66,666	Willans & Robinson, 1 to 80,000 & 80,001 to 116,666	£5	8 %	8 %	Nil	Nil	¾ — 1¼	¾ — 1¼	..	..	..
66,666	Do. 6 % C. P., 80,001 to 80,000 & 125,001 to 141,666	£5	..	6 %	Nil	Nil	2⅜ — 3¼	2⅜ — 3½	..	..	..
246,806	Do. 4 % 1st Mort. Deb. Stock	£100	..	4 %	4 %	4 %	77 — 82	77 — 82	..	..	..

ELECTRICITY SUPPLY COMPANIES.

14,000	Bromley (Kent) E.L. & P., 1 to 14,000	£5	..	5 %	5½%	4 ⅜§	5⅛ — 5⅜	5⅛ — 5⅜	..	..	..
50,000	Do. do. 4½ % 1st. deb. stock	£100	..	4½%	4½%	4½%	101 —104	101 —104	..	..	..
29,377	Brompton & Kens. Elec. Lt. Sup., Ord., 1 to 20,000	£5	8 %	10 %	10 %	10 %	8 — 9	7¾ — 8⅜ xd	..	..	..
10,623	Do. do. 7 % Cum. Pref.	£5	7 %	7 %	7 %	7 %	7¾ — 8¼	7⅞ — 8 xd	..	..	—1
800,000	Central Electric Supply 4 % Guar. Deb. Stock	£100	4 %	4 %	4 %	4 %	101 —104	100 —103	..	..	..
80,000	Charing Cross and Strand Electricity Supply	£5	10 %	8 %	8 %	5 %	4 — 5	4 — 5 xd	..	..	..
80,000	Do. do. do. 4½ % Cum. Pref.	£5	4½%	4½%	4½%	4½%	4⅜ — 4⅞	4⅜ — 4⅞ xd	..	..	..
40,000	Do. "City Undertaking" 4½ % Cum. Prf.	£5	4½%	4½%	4½%	4½%	4 — 4½	4 — 4½	..	..	..
40,000	Do. do. 1908	£5	..	4½%	4½%	4½%	4 — 4½	4 — 4½	..	..	..
420,000	Do. do. 4 % Deb. Stock Red.	£100	4 %	4 %	4 %	4 %	99 —102	101 —104	..	..	+2
44,436	Chelsea Electricity Supply, Ord.	£5	4½%	5½%	6 %	6 %	5½ — 5⅝	5½ — 5⅝	..	..	..
175,000‡	Do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	106 —108	106 —108	..	..	..
70,595	City of London Elec. Lighting, Ord. 40,001—110,595	£10	5 %	5 %	6 %	6 %	10 — 10⅜	10½ — 10⅝	10⅜	10 5/16	+ ⅛
40,000	Do. 6 % Cum. Pref., 1 to 40,000	£10	6 %	6 %	6 %	6 %	11⅜ — 12⅛	11⅜ — 12⅛	..	..	..
400,000‡	Do. 5 % Db. Stk., Scrip. (iss. at 115) all pd.	..	5 %	5 %	5 %	5 %	122 —125	123 —126	..	..	+1
300,000	Do. 4½ % 2nd Db. Stk., Prov. Crts., all pd.	£100	4½%	4½%	4½%	4½%	100 —103	100 —103	..	..	..
40,000	County of Durham Electrical Power, Ord.	£2	4 %	4 %	£3 7 0	4 %	2 1/16 — 3 3/16	2 1/8 — 3 3/16	..	..	..
50,000	Do. do. 5 % Pref.	£5	5 %	5 %	5 %	5 %	5 — 5⅛	5 — 5⅛	..	..	..
40,000	County of London Electric Lighting, Ord. 1—40,000	£10	4 %	4 %	4½%	5 %	8 — 9	8 — 8½ xd	..	..	..
80,000	Do. do. 6 % Pref., 40,001—80,000	£10	6 %	6 %	6 %	6 %	11⅛ — 12⅛	11⅛ — 12⅛ xd	..	..	..
400,000‡	Do. do. 4½ % Deb. Stock	..	4½%	4½%	4½%	4½%	107 —110	107 —110	108½	..	..
400,000	Do. do. 4½ % 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	101 —104	101 —104	..	..	..
80,000	Edmundson's Electric Corporation, Ord. Shares	£5	7 %	7 %	7 %	4 %	3½ — 3⅝	3½ — 3⅝	66/3	..	..
80,000	Do. do. 6 % Cum. Pref.	£5	6 %	6 %	6 %	6 %	4¾ — 5⅛	4½ — 5⅜	5	..	..
820,000	Do. do. 4½ % 1st Mort Deb. Stk	£100	4½%	4½%	4½%	4½%	100 —103	100 —103	..	..	..
10,000	Folkestone, 1 to 10,000	£5	..	5½%	5½%	5½%	5⅛ — 5⅜	5⅛ — 5⅜	..	..	..
10,000	Do. 5 % Cum. Pref., 1 to 10,000	£5	..	..	..	5 %	5 — 5⅛	5 — 5⅛	..	..	..
75,000	Do. 4½ % 1st. Deb. Stock	£100	..	4½%	4½%	4½%	99 —102	99 —102	..	..	..
18,000	Hove, 1 to 18,000	£5	..	8½%	8½%	9 %	7⅞ — 8⅛	7⅞ — 8⅛	..	..	..
10,000	Do. New (£6 10s. paid)	£13	..	8½%	8½%	9 %	6⅞ — 6⅞	6⅞ — 6⅞	..	..	..
87,309	Do. 4 % Deb. Stock	£100	..	4 %	4 %	4 %	99 —101	99 —101	..	..	..
7,300	Do. 4½ % Deb. Stock	£100	..	4½%	4½%	4½%	99 —101	99 —101	..	..	..
21,000	Kensington and Knightsbridge Electric Ord.	£5	10 %	12½	12 %	10 %	9⅜ — 10⅜	9½ — 10⅜	..	..	..
90,000	Do. do. do. 4 % Deben. Stk.	Stock	4 %	4 %	4 %	4 %	97 —100	98 —101	..	..	+1
111,000	London Electric Supply Corporation, Limited, Ord.	£1	Nil	Nil	3 %	4 %	1⅞ — 2⅜	1⅞ — 2⅜	40/-	..	..
60,000	Do. do. 6 % Pref...	£5	6 %	6 %	6 %	6 %	5 — 5⅜	5 — 5⅜	..	..	..
574,396	Do. do. 4 % 1st Mort. Deb. Stk. Red.	Stock	4 %	4 %	4 %	4 %	96 — 99	96 — 99	..	..	..
200,000	Metropolitan Electric Supply, 1 to 100,000	£5	7½%	8½%	10 %	10 %	8 — 9	8 — 9 xd	8 7/16	8⅛	..
76,121	Do. 4½ % Cum. Pref. 1—71,106, £3 pd.	£5	4½%	4½%	4½%	4½%	5½ — 5¾	5½ — 5⅝	..	..	..
230,000‡	Do. 4½ % 1st Mort. Deben. Stock	..	4½%	4½%	4½%	4½%	109 —113	109 —113	..	..	..
250,000‡	Do. 3½ % Mort. Deben. Stock Redem.	Stock	3½%	3½%	3½%	3½%	94 — 96	95 — 97	..	..	+1
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	£100	4½%	4½%	4½%	4½%	98 —101	98 —101	..	..	..
75,000	Newcastle-on-Tyne, 1 to 75,000	£5	..	8 %	8 %	8 %	7⅞ — 8	7⅞ — 8	..	..	..
75,000	Do. 5 % Pref., 1 to 75,000	£5	..	5%	5 %	5 %	5⅝ — 6⅛	5⅝ — 6⅛	..	..	..
10,852	Notting Hill Electric Lighting	£10	6 %	6 %	7 %	7½ %	13⅜ — 14½	13⅜ — 14½	..	..	..
64,000	Do. do. 4 % 1st Mort.Deb...	£100	4 %	4 %	4 %	4 %	97 — 99	97 — 99	..	..	..
18,500	Oxford, 1 to 96 and 407 to 18,810	£5	..	6½%	7 %	7 %	6⅛ — 6⅞	6⅛ — 6⅞	..	..	..
50,000	Do. 4 % Deb. Stock	£100	..	4 %	4 %	4 %	98 —100	98 —100	..	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	£5	14½%	14½%	14½%	12½%	10½ — 11¼	10½ — 11½	..	..	..
20,000	Do. do. 7 % Pref. 20,001 to 40,000	£5	7 %	7 %	7 %	7 %	6⅞ — 7¼	6⅞ — 7¼	7⅛	..	..
150,000‡	Do. do. 3½ % Deb. Stock Red.	£100	3½%	3½%	3½%	3½%	95 — 97	95 — 97	..	..	..
12,000	Smithfield Markets Electric Supply, Ord.	£5	2½%	4 %	4 %	4 %	2 — 2½	2 — 2½	..	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	74 — 77	74 — 78	..	..	..
65,000	South London Electricity Supply, Ord.	£5	12½%	3 %	4 %	4 %	2⅞ — 3⅛	2⅞ — 3⅛	..	..	..
103,700	South Met. Elec. Lt. & Power (Ord.	£1	Nil	Nil	Nil	2½%	1 1/16 — 1 1/8	1 1/16 — 1 1/8	14/-	..	— 1/32
85,368	*(Late Blackheath and Greenwich* ‡ 7 % Pref.	£1	Nil	7 %	7 %	7 %	1⅛ — 1⅜	1⅛ — 1⅜	..	..	..
148,292	*Dist. E.L.Co.)* (4½ % 1st Deb. Stk.	£5	4½%	4½%	4½%	4½%	103 —106	103 —106	..	..	..
50,000	Urban Electric Supply, Ord.	£5	5 %	5 %	5 %	5 %	3⅝ — 4	3⅝ — 4	..	..	..
30,000	Do. do. 5 % Cum. Pref.	£5	5 %	5 %	5 %	5 %	4⅛ — 5	4⅛ — 5	..	..	..
200,000	Do. do. 4½ % 1st Mort. Db. Stk. Red	£100	..	..	4½%	4½%	98 —101	98 —101	99	..	..
110,000	Westminster Electric Supply, Ord.	£5	12½%	18½%	14½%	12½%	9⅜ — 10⅜	9½ — 10½ xd	10 1/16	10	..
28,151	Do do. 4½ % Cum. Pref.	£5	5 %	5 %	5 %	5 %	5½ — 5⅝	5½ — 5⅝	5 1/16	..	..
	(Originally 5 %—Red. to 4½ % from 31st Dec., 1905.										

Shares not officially quoted:—Mackay Companies, ord., 75—77. Pref. 75—77.
† Unless otherwise stated all shares are fully paid. § Interim dividends.

(Bank rate of discount 3½ per cent. June 21st, 1906).

THE DAVIES PATENT WATER-TUBE BOILER.

We have received a pamphlet relating to the Davies patent boiler, which is interesting because it is built with a combustion chamber lined with firebrick after the manner long advocated in these columns—that is to say, the gases pass into the combustion chamber before they have been exposed to a large amount of boiler heating surface. The whole of the tubes are vertical, and disposed in three longitudinal banks. Between the banks there are inserted the pipes of the superheater, and a horizontal tube economiser is placed at the base of the up-take. The upper drums form the roof of the tube chamber, with a steam receiver above; the bottom drums form the roof of the furnace, and the latter is divided into compartments by firebrick walls (see figures). The large combustion chamber at the back of the boiler is lined with brick. There are no separate downcomer tubes; the back rows act as up-cast, and the front rows are downcomers. Feed water is introduced at the front end of the upper drums, and immediately passes down the tubes. Access to the tubes is gained by hand-holes in the upper drums, and almost every tube can be withdrawn without disturbing other tubes—in fact, when so specified, provision is made for withdrawing every tube without exception. Manholes in the ends of the drums enable a man to enter any of these for inspection or cleaning purposes. Hinged smoke-box doors are fitted to the front of the boiler, which in general arrangement, as will be gathered from the figures, somewhat resembles a dry-back boiler, the path of the gases being quite the same.

The design of the boiler enables the grate area to occupy a very large proportion of the floor space covered, so that a large evaporative output is gained per square foot of space occupied. Forced draught, mechanical stoking, &c., can easily be applied, and it is especially claimed for the Davies boiler that it is practically smokeless, while it burns any kind of fuel. The outside of the boiler being wholly encased in iron sheeting, inward leakage of air is entirely prevented.

The pamphlet is further of interest because it contains copies of tests made by three separate engineers, two of whom find practically the same figures. The first is by Mr. W. H. Booth, who gives the calorific capacity of the Nixons Navigation coal as fired as 14,962 B.TH.U. by the Bombe method. Mr. Donkin comes next, and gives the same coal tested dry as 15,025 B.TH.U., which practically corresponds with the figure for 14,962 of the undried coal. The third test, by Mr. W. J. Harding, also with Nixons Navigation, gives no calorific value for the coal.

Test No. 1 gives the efficiency of boiler, economiser and superheater combined as 86·3 per cent., and the *apparent* efficiency of boiler alone, 81·28 per cent., but as this was due partly to the superheater, the true boiler efficiency is considered to be about 2 per cent. less, or 79·28 per cent. Mr. Donkin finds the total combined efficiency on a somewhat higher rate of working to be 85·42 per cent., and for the boiler alone 79·3 per cent., which is practically that of Mr. Booth's test. The test by Mr. Harding, assuming the figure 14,962 B.TH.U. as the calorific value of the coal, gives a result which is stated as 13·9 lb. evaporation from and at 212° F., and this appears to represent an efficiency of 89·7 per cent., which we regard as impossible. Moreover, this appears to be for the boiler only, and not to include economiser or superheater.

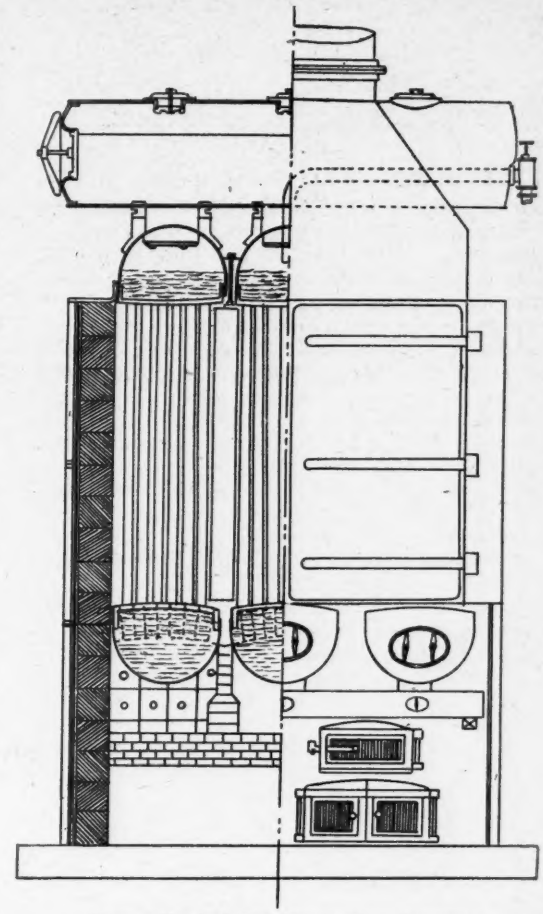
It appears to us that the boiler efficiency of 79·3 per cent. obtained in the first two tests cannot be complained of under the conditions of the trial as to rate of combustion, but to secure another 10 per cent. is not possible, nor is it consistent with the figures for chimney temperature, and we regret that such a figure should have been found by an ex-naval engineer and a M.I.C.E., for a boiler which is good enough without exaggeration.

In test No. 1 the absorptive efficiency of the boiler plus superheater is given as only 88·91 per cent. of the heat supplied above the boiler temperature. Yet No. 3 test claims actually more for the boiler alone, on the total heat capacity of the coal.

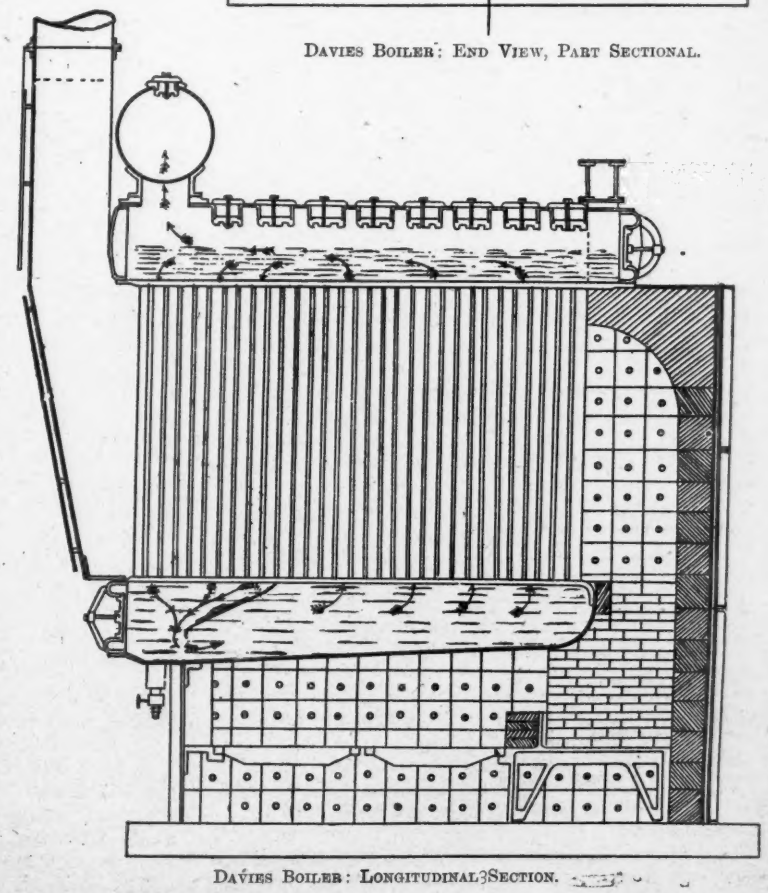
In other words, Mr. Harding finds 13,427 B.TH.U. in the saturated steam, and as he gives an up-take temperature beyond the economiser of 558° F., at least 2,000 B.TH.U. must have gone up the chimney, so that only about 13,000 B.TH.U. remain to supply the above 13,427 plus feed heating plus 80° of superheat. Whence comes it all?

A later test than the three above was made with Tanfield Moor coal, which is a bituminous Durham coal, and it is stated in the pamphlet that the results were practically smokeless, owing, no doubt, to the refractory combustion chamber, which, with the straight small tubes, should help to make this boiler very useful and satisfactory.

The water evaporated per pound of actual coal in Mr. Booth's test amounted to 11·616 lb., at 77 lb. pressure, equivalent to 12·59 lb. from and at 212° F., burning 14 lb. of coal per sq. ft. of



Davies Boiler: End View, Part Sectional.



Davies Boiler: Longitudinal Section.

grate area per hour; the total evaporation was 4,822 lb. per hour, from and at 212° F. In Mr. Donkin's test the evaporation was 10·53 lb. per lb. of actual coal, at 171 lb. pressure, or 13·35 lb. from and at 212° F. per lb. of dried coal, the total evaporation per hour being 6,690 lb., burning 19·44 lb. coal per sq. ft. of grate per hour.

THE BRITISH ASSOCIATION.

Prof. Ewing's Address to Section G.

The usual practice of Presidents of Sections at the British Association is to give an account of the recent advances in their sciences. Many of the Presidents at the York meeting devoted themselves to giving a history of scientific progress during the 25 years which had elapsed since the Association last met in the city of its birth.

Prof. Ewing, in his excellent address to Section G, did not follow this practice, but gave, instead, an exposition of recent researches on the strength of iron which will be of the greatest interest and value to engineers. Prof. Ewing's style is always lucid, and he had, moreover, the advantage of being thoroughly master of his subject, since the recent progress in our knowledge of the strength of iron is mostly due to his own researches.

The electrical engineering profession has to thank Prof. Ewing for the discovery of hysteresis, and no doubt most of its members are acquainted with the beautifully simple model of the molecular constitution of a magnetic material by which he explained that well-known phenomenon. This model he has now modified and adapted to explain in an equally beautiful and simple manner what molecular disturbances take place when a piece of iron or steel is subjected to stress.

The fundamental idea to be got hold of in order to understand the theory of the strength of metals, is that their natura

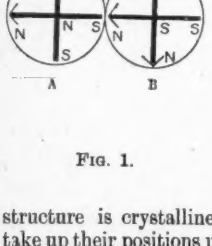


Fig. 1.

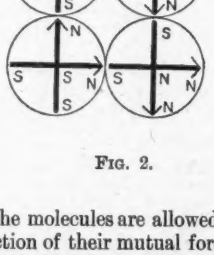


Fig. 2.

structure is crystalline. When the molecules are allowed to take up their positions under the action of their mutual forces, they build themselves up into crystals, of invariable form, which continue to grow till their boundaries meet. The ideal condition for the formation of these crystals is the solidification of a metal from the liquid state. But the process may in certain conditions go on slowly at very moderate temperatures. The process of annealing is essentially the raising of the metal to a temperature at which recrystallisation may take place, though the metal remains solid while this internal rearrangement of its particles goes on. Quick cooling means that the crystallisation starts from many nuclei, and the resulting grains are consequently small, while with very slow cooling you get a gross structure made up of grains of a much larger size.

It has been shown by Ewing and Rosenhain that when a piece of metal is strained beyond its limits of elasticity, so that permanent set is produced, the yielding takes place by means of slips between one and another portion of each crystal grain. A part of each crystal slides over another part of the same crystal as you might slide the cards in a pack. These lines of shear or slip can be detected by examining under a microscope the polished surface of a piece of metal which has been somewhat severely strained. They show themselves as lines or narrow bands when looked at from above.

In the process of straining metals there is first an elastic stage, extending through very small movements, in which there is no dissipation of energy and no permanent set. When this is exceeded, the slip occurs suddenly, the work done in straining is dissipated; if the straining force is removed, a strain persists forming a permanent "set." In general, a large amount of strain may take place without destroying the cohesion between the gliding surfaces. Immediately after the strain has occurred, there is marked fatigue, showing itself in a loss of perfect elasticity, but this will disappear with the lapse of time, and the piece will then be harder than at first. If, on the other hand, a process of alternate straining backwards and forwards b- many times repeated, the piece breaks.

How are these peculiar phenomena in the process of straining metals to be explained? This is the aim of

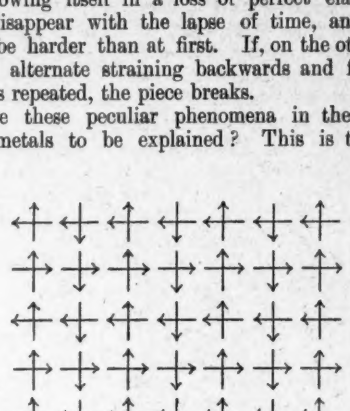


Fig. 3.

Prof. Ewing's theory. Iron and most other useful metals crystallise in cubes. Ewing imagines that these cubes are built up of molecules with six poles, three positive and three negative. The opposite poles of the molecules attract each other, and build up a cubical structure, the molecules having perfect freedom to rotate on their axes. Fig. 1 shows a side view of two of these molecules in combination, and fig. 2 shows four in combination. A model can be made by using small magnets to represent the poles of the molecule. If these model molecules are mounted on central axes at right angles to the plane of the magnets, and arranged as shown in fig. 3, many of the phenomena which appear in the process of straining a metal can be illustrated. Fig. 3 shows the arrangement with maximum stability, but there are other arrangements which are stable, though to a less degree than the maximum. If two neighbouring molecules in the same block be turned round, each through one right angle in opposite senses, they will now each have five poles touching five poles of contrary name, but the sixth pole will touch a pole of the same name as itself. They are still stably situated, but much less stably than in the original configuration, and they will revert to that configuration if set swinging through an angle sufficient to exceed the limited range within which they are stable in the new position.

Similarly, we may imagine a group of three, four or more molecules, each turned through a right angle, and thereby constituting a small group with more or less stability, but

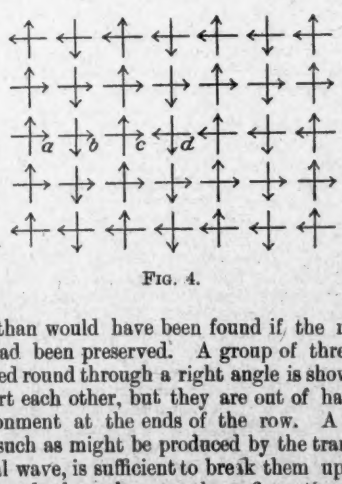


Fig. 4.

always less than would have been found if the normal configuration had been preserved. A group of three molecules *a*, *b*, *c*, turned round through a right angle is shown in fig. 4. They support each other, but they are out of harmony with their environment at the ends of the row. A slight displacement, such as might be produced by the transmission of a vibrational wave, is sufficient to break them up and cause them to swing back to the normal configuration, giving on energy which is taken up by the rest and is ultimately dissipated.

With this model and a knowledge of its behaviour under the action of disturbing forces, it is easy to understand what takes place when a metal is subjected to strain. Under the action of strain the molecules slip over each other on the plane of cleavage. Up to a certain distance the molecules rotate through a small angle, but no pole is finally separated from its mate. When the strain is taken off, the molecules return to their normal position. Here we have an explanation of what takes place when a piece of metal is strained within its elastic limits and then released.

If the displacement on the plane of cleavage passes a certain critical point, the poles of the molecules are finally torn asunder and new configurations are formed. Under the action of the disturbances caused by this slip a number of groups of inferior stability will be formed, and the strength of the metal will be permanently reduced. When the strain is relieved there will be no return to the original form. The metal will have a permanent "set."

Thus we see that by the study of Prof. Ewing's ingenious model we get the simple explanation of many of the features in the behaviour of metals under strain. The advantage of such fundamental hypotheses is that they point the way to the treatment of metals which is most likely to improve their strength and elasticity. Instead of working on the system of trial and error as hitherto, the metal worker has now at his command a rational theory which will enable him to go direct to his goal.

Glow Lamps and the Grading of Voltages.

By Sir W. H. Preece, K.C.B., F.R.S.

(Abstract of Paper read before Section G on August 6th.)

Touching on the efficiencies of modern glow lamps, the author says that by treatment in the very high temperatures of the electric furnace of the order of 3,500° C., the ordinary flashed carbon filament has recently been completely changed in its physical character. Its electric resistance coefficient has changed sign. The ohms *increase* instead of fall with heat. It behaves like a metal. It blackens the bulb much less during incandescence and it has a much longer useful life. It can be worked at an efficiency of 2·5 watts per candle. This new lamp is not on the British market yet, except for street lighting. It will tend to maintain the pre-eminence of the carbon filament, now being so vigorously assailed.

The new street lamp is supplied in three sizes:—

Watts.	Diffused candle-power.
125	70
187	105
250	140

This works out at 1·8 watts per candle-power.

A Nernst lamp of special form, fitted with a reflector for street lighting on a 200-volt circuit, and taking 51·2 watts, gave a mean hemispherical candle-power of 38·6, or 1·325 watts per candle, which was an excellent result.

These lamps apparently work equally well on either a direct or alternating system, but the frequency of the latter system should certainly be below 50.

Nine inches (280 mm.) of osmium filament, 0·087 mm. diameter give, at 37 volts, 22 c.p., with an efficiency of 1·5 watts per candle-power. The candle-power is wonderfully constant, and the actual life 2,000 hours. The bulb is said not to blacken.

In a test of 12 tantalum lamps the mean absolute life was 1,104 hours, and the mean useful life 500 hours. The filament is 650 mm. long and 0·05 mm. diameter. The current at 110 volts is 0·3654 ampere. The total watts are thus 40·19, and a mean efficiency of 2·1 watts per candle, the initial efficiency being 1·5 watts per candle.

These lamps work best on direct-current circuits, and blacken in horizontal belts with age. With frequencies below 50 the difference in behaviour on a direct or alternating circuit is scarcely noticeable.

The initial efficiency of the zirconium lamp is 1·07 watts per candle, and the normal candle-power 50. These lamps are manufactured to work with 110 and 220 volts. They blacken with age, and will work on alternating and direct-current circuits.

Dealing with carbon filament lamps only, the author points out that the life of a glow lamp is dependent on the pressure at which it is run, and incidentally refers to the higher efficiency of the 110-volt lamp as proved by American experience.

The *useful life* of a glow lamp is defined as the time taken for the M.H.C.P. to drop 20 per cent. from the standard value.

The loss of light is due as much to the blackening of the bulb as to the increase of the resistance of the lamp. The blackening is so regular in its growth through age, when the voltage is maintained constant, that Dr. Clayton Sharp proposes to classify used lamps by comparison with a scale of standard lamps artificially aged. The bulb blackening is a test independent of candle-power and of efficiency, and very quick. The lamp tells its own story.

My experiments of 1894-5 showed that interruptions in lighting made no difference to the life of a lamp, if the voltage remained constant. Messrs. Ayrton and Perry proved that it made no difference whether the currents were continuous or alternating, but subsequent experience has shown that on both systems *variation* of voltage has a deleterious influence.

The following candle-powers are recognised as standards, 8, 16 and 32 M.H.C.P. It is proposed to add to them 12 C.P. and 25 C.P. The Continental standards are 10, 20 and 30 C P.

It is impossible to tell how far lamps comply with specified standards unless they are tested on purchase and tested periodically during life. There is no difficulty in doing this when the local authority is the distributor, for several borough councils are by Parliamentary authority agents for maintaining the accuracy of the National Weights and Measures under the Board of Trade. Some of them have already seen the necessity of testing, and have established their local laboratories. The true solution is for the distributors to supply the lamps free and to maintain them. Some do this, but it is against Clause 18 of the Act of 1882. This clause is virtually a dead letter, and it should certainly be repealed or modified, for it stands in the way of a great public economical reform.

The author refers to the evil effects of voltage variation, as to which he says no serious attempt has yet been made to secure uniform pressure, throughout the network of distribution systems, by introducing voltage regulators.

The departure from the standard pressures of 110 volts and 220 volts adopted by the Engineering Standards Committee, is shown by the following table:—

Voltage of circuit.	Lighting KW.	Number of generating stations.
100	72,710	54
102	463	1
103	160	1
104	2,824	1
105	7,308	6
107	3,567	1
110	7,523	11
115	5,103	3
120	120	1
150	2,379	3
200	119,690	81
204	16,603	2
205	3,142	1
210	21,361	26
214	3,568	1
215	479	1
220	66,935	82
225	144	6
230	104,720	122
235	88	1
240	45 389	57
250	18,249	10
	512,516	472

In 472 systems only 11 adopt 110 and 82 220 volts, while 122 employ 230; most of these, however, were established before the Standards Committee was formed, but many have been established since. The whole object of a standardised system of pressures is to secure uniformity of lamps and a reduction of the very numerous processes in factories, so as to reduce their prime cost.

One of the most serious evils brought out by the inquiries of the Standardisation Committee has been the very faulty rating of the lamps by the majority of the British makers. A large number of 220-volt and 110-volt 16-C.P. lamps purchased in the open British market and sent over to New York to be compared with the American-made lamp, averaged out 13·2 candle-power and 4·51 watts per candle. The American lamps averaged 16·2 candles and 3·83 watts per candle with great uniformity.

Both sets of lamps were subjected to the American rapid life test. They were set up at 3·1 watts per candle. The English lamps averaged a life of 82 hours, and the American, 156 hours.

This experiment was repeated at the National Physical Laboratory, and the results confirmed the American figures.

The standard adopted in this country for pressures, allows a variation of 10 per cent. on either side. This means a wide margin of from 99 to 121 volts in the one class, and from 208 to 242 volts in the other. Hence lamps may be made and supplied of any voltage within these wide limits. Since the pressures are so ill selected, and manufacturers can find a market for virtually all that they make, owing to the callousness of users, no care is taken to select and stock lamps in their various grades, or to make them of uniform structure. The rejected cheap lamps of the Continent have been dumped down in this country and their marking neglected, and the author mentions a case where Continental-made lamps absorbed 9·14 watts per candle.

The chief remedy is to make the correct rating of lamps imperative. Specification and testing will be beneficial, and will tend to secure more care in selection and better efficiency. Greater regulation of pressure would facilitate the grading of lamps into groups and enforce the similar grading of our networks into zones of pressure. But falsification of brands must be made illegal. Lamps should be grouped in classes to meet this point, somewhat in the following way:—

110-volt lamps ...	100	105	110	115	120	—
220 " " ...	200	210	220	230	240	—

The author was assured by manufacturers that such grading would so improve their own output of lamps and reduce their cost of manufacture, that with a good specification they would be able not only to supply better lamps, but cheaper ones.

It must be remembered that a recent Act of Parliament allows a committee or body of people to hold a trade mark, provided they inspect. The National Physical Laboratory has its own mark and

inspects, and is, therefore, in a position to use such a mark, and so also could local authorities as authorised distributors as soon as they were in a position to inspect.

The Engineering Standards Committee have prepared, but have not finally settled, a specification which will run the risk of becoming a dead letter unless some arrangements are made for branding the lamps purporting to be to standard specification. Local authorities are already inspectors of weights and measures, and they can all become so for electric lamps; they would receive secondary standards from the National Physical Laboratory, who would periodically compare and certify their accuracy. Every authorised distributor who can afford it should contribute towards the maintenance of a well-equipped lamp-testing laboratory established on a commercial basis for testing and certifying all the lamps purchased under the new specification.

Nothing can surpass the engineering of our central stations in England, for the quality and design of our plant remains a pattern to the world, but nothing can equal our internal commercial management and the financial conduct of the business, for, as a rule, management and control are lamentably wanting. The lamp—the aim of the capital sunk—is outside their business, and the light for which payment is made is beyond their jurisdiction. Lamp control is almost universal in the U.S.A., and the gas people in the United Kingdom are even now undertaking the supervision and maintenance of mantles for a small annual charge.

Discussion.

Prof. Silvanus P. Thompson,* who opened the discussion, had a very cordial reception. He said that they stood at the beginning of a new era in incandescent electric lighting. Twenty-five years ago the Swan lamp was the last new thing. To-day they had those newer incandescent lamps whose inefficiency was lower or their efficiency higher. They had been talking for years about what was miscalled an efficiency of 3 watts per candle. This was an inefficiency, it was what they paid for watts per candle. They were getting down to those lamps which had an inefficiency of only 1½ watts per candle, that was a real efficiency of two-thirds of a candle per watt. They would have to cease talking about watts per candle, and speak instead of candles per watt. One did not like to be sounding the note of the departure

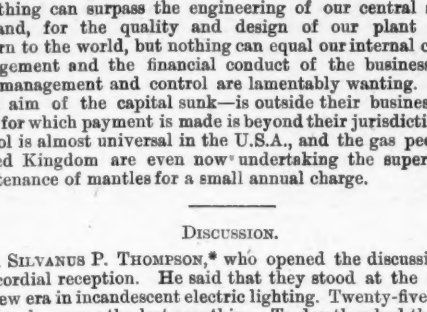


Fig. 1.—Langley's Curve of Relative Luminosity for Equal Amounts of Energy.

of the carbon glow lamp, but it looked like it, indeed, with those newer materials. A number of lantern slides were thrown upon the screen to show curves of the sensitiveness of the eye, and the radiation from different bodies at different temperatures. The eye was sensitive to radiations of wave-lengths between 75 and 40 millionths of a centimetre, being most sensitive to light waves about 50 millionths of a centimetre in length. Now, if they took an absolutely black body at the temperature of the glow-lamp filament—about 2,000° of the absolute scale—it radiated all sorts of rays, of which about 99 per cent. were mere invisible heat-rays of a longer wave-length than 75 millionths of a centimetre, the dominant wave-length at that temperature being 147 millionths of a centimetre. If they could raise the temperature to 3,000°, they would not only get more radiation, but they would get a radiation of which a greater percentage was visible; for at that temperature the dominant wave-length for the absolutely black body was 98 millionths of a centimetre, the peak of the curve shifting nearer to the visible part of the spectrum. The carbon arc was at about 4,000° absolute, with a dominant wave-length of 74 millionths of a centimetre, just at the red end of the spectrum; while at the temperature of the sun, which was about 6,000°, the dominant wave-length would be just about 50 millionths of a centimetre. These figures were for the absolutely black body. Carbon was not, however, absolutely black. If they passed to the case of a brightly polished metal such as platinum or osmium, the case was different. Everybody knew that the brightly-polished surface, because it was a good reflector, was a bad emitter. For an equal amount of surface and at an equal temperature, it radiated

Temperatures and Dominant Wave-Lengths of Radiation.

—	Centigrade.	Absolute.	$\lambda_{dom.}$
Sun	5,880°	6,153	50
Carbon arc	3,800°	4,073	72
Welsbach mantle	(?) 2,027°	2,300	128
Nernst lamp	2,027°	2,300	128
Platinum melts	1,775°	2,048	143
Bunsen flame	(?) 1,750°	2,023	145
Carbon glow lamp	1,727°	2,000	147
Gas flame	1,613°	1,886	157
Candle flame	1,577°	1,850	159
Gold melts	1,250°	1,523	195
Silver melts	1,000°	1,273	230
Water boils	100°	373	790
Ice melts	0°	273	1,080

Wave-lengths given in micro-centimetres.
Visible radiations lie between λ = 81 and λ = 36.

* Speakers whose names are marked with an asterisk have kindly corrected the proofs of their remarks.

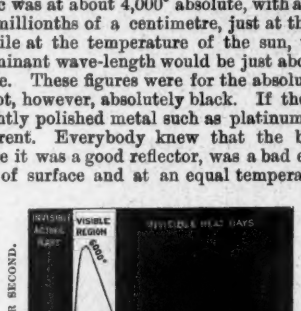


Fig. 2.—Relation Between Absolute Temperatures and Dominant Wave-Lengths of Radiation.

less than a black body. But here came in the crux of the whole matter. Lummer had shown that although at the same temperature bright platinum had a lesser radiative power than the black body, its radiation was of a more favourable quality; the peak of the curve, though lower, was shifted nearer to the visible region. Thus while for the black body at 1,646° the dominant wave-length was 180 millionths of an inch, for platinum at 1,689°, nearly the same temperature, the dominant wave-length was 160. Platinum was not

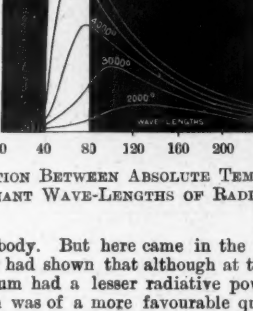


Fig. 3.

suitable because of its low melting point; but the newer filaments of osmium, tantalum, tungsten, and zirconium appeared to promise very efficient lamps, because they gave bright filaments at higher temperatures than could be used with carbon filaments. Furthermore, these wires could be cut off to the required lengths with more certainty than carbon filaments. He was sorry to differ from Sir William Preece about the grading of lamps. He agreed that standards should be adopted, but thought it a pity to waste time over grading for 5 volts more or fewer than the standard voltages. That was a concession to the carbon lamp-makers to enable them to classify their wasters. Why should they not make their lamps of the exact voltages to begin with?

Col. Crompton* said that he must differ from the last speaker as to luminous efficiency being altogether an affair of temperature. Moreover, he thought that if they were not to standardise the carbon filament lamps, in view of probable developments of metallic filaments, there would be an end to the hopes of standardisation. Whether or no tantalum or other metallic filament lamps were successfully produced, the question of graded voltages put forward by Sir William must be carefully considered, and in most respects he was heartily in agreement with the author of the paper. It was true that the American system of including the supply of the electric lamp with that of the electrical energy had worked favourably for the user, as the control which it thereby gave to the supply authority had resulted in a decided improvement in lamp manufacture, but, at the same time, in America the conditions of lighting differed somewhat from those in this country, for there the smaller proportion of the electric supply was used for private lighting, whereas here the reverse was the case. It followed that the American system of supplying current and lamp was easily carried out over there, whereas in England, where they dealt with a very large number of small consumers, it would be much more difficult—at any rate, it was the last condition which had introduced the present loose system of lamp manufacture, and had made this country a dumping ground for inferior and badly standardised lamps. Sir William had spoken in terms of blame

of the large number of voltages in use, but this was the natural result of the experimental and gradual development of the carbon filament lamp. The engineers who designed our systems of electric supply had always before them the necessity for economy in their distribution to enable them to compete with the existing gas companies, and therefore naturally availed themselves of the highest voltage lamps obtainable. He thought it necessary also to point out that the author had not made it quite clear why the Standards Committee had chosen the existing standard voltages. Those voltages were chosen in order to enable manufacturers of motors to reduce the number of their patterns. It was believed, and found to be true in practice, that motors could be made and wound for voltages of 110, 220 or 440, which would with no alteration suit voltages varying 10 per cent. above or below those standards fairly well. Those standard voltages were therefore chosen with that object, and if the author's table were examined, it would be seen that 62 per cent. of the existing systems were within 5 per cent. of the standard voltages. As regards the grading of the carbon filament lamps themselves, there could be no doubt that lamp manufacturers would find that it greatly economised in their manufacture if they were able to mark and sell lamps of 96, 98, 100, 102 and 104 for a 100-volt supply system, or with similar percentage variations for 200 or 220 volts, but this necessitated the American system of grading the voltages in the supply, a matter much easier in America on account of the steadying motor load than would be the case here, where the motor and heating load were at present much smaller. Turning to Prof. Thompson's remarks, he did not think that this was a time to point out that luminous efficiency was so greatly an affair of temperature. If it were true, how would it be possible to account for the high efficiency of the flame arc lamp, as undoubtedly the temperature of the flame arc lamp was much lower than that of the pure carbon lamp? No doubt what they required was the best combination—that was to say, a sufficiently high temperature combined with a sufficient increase of light-giving surface, such as was given by the luminous cloud of the flame arc. He had recently discussed this matter with a distinguished Frenchman—M. Blondel—who had made great developments in the flame arc, obtaining in some cases, even with quite small lamps, efficiencies as low as one-sixth of a watt per candle in the lower hemisphere. This efficiency was 30 per cent. better than the well-known yellow flame lamps, such as those that had been used for the lighting of the Exhibition building where the lectures were given.

Mr. Robert Hammond* said that, when one remembered the haphazard way in which the manufacture of incandescent lamps was carried out 25 years ago, one must acknowledge that immense progress had been made. If Sir William had a chance of re-writing a certain paragraph in his paper, he would not be so strong in writing that 25 years had seen so little advance. He believed it to be possible in the most modern works to make lamps strictly to specification. They had factories in England where it was not a matter of conjecture, but of absolute accuracy of work, so that incandescent lamps could be turned out to exact voltages and efficiencies. He agreed with Sir William that all lamps should be marked with their voltages, efficiencies and candle-power, and those marks upon them should come directly under the Weights and Measures Act. The electrical industry had suffered for many years from the villainy of those who had misrepresented their lamps in voltage, candle-power and efficiency. Sir William pointed out that the consumer at the present time had no protection, but under the Electric Lighting Act it was carefully provided that an inspector should be appointed under every provisional order. It was curious to think how very few inspectors had been appointed in this country. The undertakers seemed to have thought that the expense was such that those gentlemen were not worth having. In respect of 95 per cent. of the orders, no inspectors had been appointed. They could not touch the question of the efficiencies of the lamps, because that matter, by the provisions of the 1882 Act, was outside the province of the undertaker. If one outcome of this paper were the compulsory marking of incandescent lamps, and their being brought under the Weights and Measures Acts, a very great step would have been taken to raise the life and efficiency of incandescent lamps in this country. They were constantly saying that voltages should be standardised. The table shown by Sir William indicated what a large number of places throughout the country had the so-called absurd voltage of 230. The difficulty of standardising was this—they might alter the voltage of supply, but every lamp in every place, outside the range standardised, would have to be changed, and local people very much objected to the expense thereby entailed.

Mr. L. Gaster, in the course of some remarks, suggested the establishment of a very large testing bureau, to the cost of maintaining which municipalities should each contribute a very small amount. Here lamps could be tested according to a scheme which could be worked out representing the manufacturers, the consumers and everybody concerned. He also paid a tribute to the Standards Committee for the labour undertaken in this matter, and for bringing manufacturers and the Committee together.

Another speaker gave particulars of a number of tests he had made of English and American lamps which came out badly for the English maker. If they took the very best American and English filaments, they would both be subject to the same unsatisfactory conditions on English circuits; inevitably neither would show a satisfactory result. Some of them would burn at too low an efficiency, and some at too high, but if they put best English lamps on American circuits and gave them American grading of voltages, they would see a very different result from the comparison.

Sir William Preece,* in reply, said that the object with which he wrote the paper had been fully attained. It would, if he succeeded in reaching the people he had in his mind, attract the attention of the local authorities and managers of electric lighting systems whose vagaries he was driving at. He was never alarmed at criticisms. He found that in discussions, people often contradicted each other. He was glad he had had such strong support. He would like to point out to Prof. Thompson that he had omitted one thing. It was always the case when they had a problem attacked from the physical side. There was some important point on the practical side that had been forgotten. The greatest scientific authority of the day came down to the Institution of Civil Engineers and pronounced his dictum that it was impossible to lay an Atlantic cable. He was quite right on his own assumptions, but he was quite wrong, because he omitted from his conditions the most important factor of all. Prof. Thompson was all right about temperature, energy and light, but there was this one point he did not mention—that platinum, osmium, zirconium, and carbon had each their melting points, and the ultimate efficiency of a lamp was entirely dependent upon the temperature they got. Platinum broke at 1,900°; carbon went higher; the new carbon higher still, and zirconium and osmium went up to nearly 2,300°; but there was no material in the practical world at present that they could make into a filament that would exceed 2,300°, so that their practical lamp was limited by the melting point of the material used for the filament. He concluded by urging upon users the value of reading Acts of Parliament. In the Electric Lighting Acts, with the aid and power of the Board of Trade, a combination of half a dozen or so users could raise any point they liked; they could establish testing stations, and if they would read their Acts of Parliament they would know more about electric lighting than they knew at present.

The Advent of Single-phase Electric Traction.

By C. F. Jenkin.

(Paper read before Section G on August 6th.)

(*Concluded from page* 247.)

Turning now from the advantages of electrification in general, let us consider how it should be carried out.

Electrification will begin at many isolated centres; usually in densely populated districts or where there is a large holiday traffic. Then these independent lines will extend and gradually join up. This has been the experience in America with the tramlines, which now cover hundreds of miles with continuous tracks. The Coeln-Bonn line and the Vienna-Baden line are examples of the same thing on the Continent. This being so, it is of great importance that the system adopted for the local lines should be suitable for the longer connecting lines, so as to avoid any discontinuity when the linking-up begins. In other words, preference should be given even on short lines to the system which is also suitable for the long lines.

For all lines, whether short or long, the transmission is always done, for the sake of economy, at high tension. The important question is: How shall the power be distributed to the trains?

The alternatives are—by means of a third rail on the ground, or a trolley wire overhead. If the third rail on the ground is chosen, the voltage must be kept low, and the current therefore will be large. If overhead trolley wire is used, the current must be small, therefore the voltage must be high.

For use with the low-tension third rail, the best motors are continuous-current motors. With the high-tension trolley wire the only motors are alternate-current motors, because it is only alternating current that can be transformed on the car to a voltage suitable for the motors. High-tension continuous-current motors can be built up to moderate pressures, but are not likely to have any wide field of usefulness.

Thus we see that the two alternatives are:—

1. The ordinary composite system of high-tension alternate-current transmission converted to low-tension continuous current distributed by means of the third rail.

2. The high-tension trolley wire and alternate-current motors.

The objections to (1) for long lines are:—

(*a*) A fourth rail is necessary to bring back the large currents.

(*b*) The third and fourth rails are in the way, particularly at junctions.

(*c*) There have to be sub-stations with running machinery distributed along the line.

All these objections are got over by the second system, where the currents are so small that a fourth rail is not needed, and the third rail is out of the way overhead, and there are only a few stationary transformers along the line. The consideration, therefore, of the permanent-way equipment leads us inevitably to the conclusion that an alternating system is better than a continuous-current system.

There are two alternating-current systems possible—three-phase and single-phase. The three-phase system has certain advantageous properties, and has been most successfully used on some mountain lines and on the interesting Valtellina line in Italy. It has, however, one disadvantage, so serious as to outweigh all other considerations—viz., that it requires two trolley wires. There are other disadvantages connected with the motors which may be about balanced by their special advantages, but this one requirement is the determining factor.

When one considers that this requirement of two trolley wires affects the whole length of the line, with all stations, sidings, yards, &c., its importance becomes apparent. The overhead line becomes enormously more difficult to construct when there are two conductors which have to be kept insulated, not only from the ground, but also from one another, even when the trolleys are passing the junctions.

Thus we are led almost of necessity to the single-phase system, in which the overhead construction assumes the simplest form. All the wires at junctions, &c., may be connected, and the collector bow slides from one to another without attention, and without any provision of switches and frogs or insulated sections in the wires.

Many arguments have been brought forward against single-phase traction. The motors are said to be less efficient, to be heavier, to run hotter, to spark, to have too little clearance, to be more expensive—in fact, to possess every sort of disadvantage. I do not propose to discuss all these questions to-day. I wish to rest the whole claim of the single-phase motor on the one fact which must outbalance all other considerations—the fact that it only requires a single light trolley wire to supply it with any amount of power. Of course, if the motor were so poor that it would not work satisfactorily, my argument would fall to the ground; but it has already done such excellent work that this cannot any longer be suggested.

I now proceed to describe shortly the general arrangement of a single-phase equipment, and then to point out some of the more interesting problems which arise in practice, and to show how they have been solved.

The equipment of the line is very similar to the well-known continuous current tramway arrangement. A single copper trolley wire is suspended over each line of rails, and as all the wires over parallel or crossing lines of rail are at the same potential, they may be connected, the only insulation required being between wire and earth. The current is collected by means of bow collectors, which slide under the trolley wire; and as all the wires are at the same level at junctions, the bow slides freely from one to another without attention. The return current flows through the rails. Power is supplied to the trolley wire from feeders, when the length of line requires them. Voltages of 3,000, 6,000, 10,000 and 15,000 for the trolley wire are already in use, and 20,000 has been successfully used experimentally, in Sweden. The feeders may be at any voltage; they can be carried as bare wires on the poles; 30,000 volts is being used for the feeders at Hamburg, with stationary transformers to reduce the feeder voltage to the line voltage. The power may be supplied from one or more power stations, and may be generated as single or polyphase current; but if polyphase generators are used, the phases must be kept separate and used for different sections of the line, which is usually troublesome.

The motor-cars are equipped with one or more motors, each of which is fed from a transformer in the car which reduces the trolley pressure to a moderate one—between 300 and 500 volts. The speed is controlled without loss in resistances by varying the voltage supplied by the transformer, or by a combination of this method with variation of the excitation by means of a small auxiliary transformer.

The switching is done by means of contactors operated directly by single-phase magnets, or by compressed air controlled electrically. The rest of the car equipment is similar to continuous-current plant—master controller, reverser, automatic, main-switch, &c. Braking can be done by means of the motors, with the addition of resistances; but so far no simple method has been devised by which the motors can return power to the line. The auxiliary services of lighting and heating are very easily provided for, any voltage being available. Low-voltage lamps do not flicker perceptibly with periodicities as low as 25 or even 15.

Turning now to the details. The overhead line construction has none of the difficulties connected with the third rail, the awkward gaps which occur where rails cross being no longer necessary. The common tramway trolley line hangs in curves, so that there is a more or less sharp angle at each point of support. These angles are somewhat reduced by the lift given to the trolley wire by the bow, but they cannot be made nearly straight; it is therefore obvious that the collector bow on a car can only follow these curves when moving very slowly, since the sudden change of direction of motion at the point of support will require a large force to produce it even at moderate speeds. There is always, therefore, more or less of a blow as the bow passes the supports, and the combination of the bending and the blow at the point of support results in frequent breakages. Statistics show that trolley wires break at the rate of about one per day in England, notwithstanding careful inspection and renewals. For high speeds it is, therefore, necessary to support the trolley wire in an approximately straight line, and only to vary its direction very gradually, and many arrangements for this purpose have been designed. Modifications of the catenary suspension have so far been the most successful, and one of the new designs is so simple that it leaves very little to be desired.

In its simplest form the trolley wire is hung at short intervals from the catenary wire by means of vertical wire droppers. The catenary wire is strained tight to prevent side swing. In this design temperature variations produce large distortions, and it is difficult to adjust the large number of droppers so that each will take its proper share of the weight of the light trolley wire.

An improvement on this is the use of two catenary wires, the trolley wire being hung between and below them. This arrangement is much steadier sideways, but is still more difficult to erect owing to the very large number of droppers.

The latest design goes back to the single catenary, but gives it a considerable sag, so that temperature distortion is reduced to a small amount. Under the catenary is hung an auxiliary wire by means of a few vertical droppers, and from this the trolley wire hangs by means of little loops all of the same size. By this arrangement the number of droppers to adjust is reduced to one-quarter the number in the double-catenary design, and, as the weight on each is also four times as great, the adjustment is much easier. The small loops are spaced about 10 ft. apart, and the trolley wire is sufficiently stiff to hang from these as a continuous girder, taking no permanent kink at the points of support. As the bow travels along it lifts a short length of the trolley wire a few inches; this is allowed for by the loops which rise off the auxiliary wire, and thus a beautifully smooth motion is obtained. A further advantage of this design is that the trolley wire is free to slip endways, and can be strained up without dragging the droppers out of the vertical. To prevent sideways swing, the auxiliary and trolley wires are stayed to each post. On the clear line the catenary may be supported on poles with side-arm brackets, or on light beams supported on poles at each side.

In England most bridges are so low that the catenary construction cannot be carried through under them. The catenary wire may then be anchored to the bridge, and the two other wires taken through; these may be supported on short-span wires fixed against each face of the bridge, with additional span wires every 20 ft. under the arch if the bridge is long. In tunnels there is sometimes room to carry the ordinary construction through; but if not, a construction like that under bridges may be used. Rigid conductors might be used, but for high speeds the elasticity of the trolley wire is advantageous. In stations the overhead construction can often be suspended from the roof.

The trolley wire must be divided into sections to enable faults to be located and cut out, without interfering with the whole system. The design of a satisfactory section insulator for high voltages is not easy, so several methods have been devised for sectioning the line without the use of a mechanical section insulator. The simplest method is to anchor the ends of adjacent sections side by side, so that they overlap a short distance, arranging the levels so that the bow slides off one and on to the other smoothly.

The rails are used as the return circuit, with copper feeders if necessary. As the rails are made of magnetic material, the skin effect makes their resistance to alternating currents much higher than their resistance to continuous currents—usually three to six times as high—but the currents are so small that this disadvantage is not serious. The resistance to alternating currents is not a constant, but depends on the periodicity and current. The return circuit is far from being non-inductive, therefore the drop of volts depends not only on the resistance, but also on the self-induction of the circuit. The whole drop, due to both resistance and induction, may be kept as small as is desired by means of small sucking transformers, which suck the return current out of the rails into a return feeder. All danger from shocks from the rails may be avoided by using earth-plates connected every ½ mile or so to the rails. This procedure may be safely used in long lines which run mainly through the country, but is less suitable for the parts of the line running through towns; these are, however, usually short. Electrolysis has so far given no trouble with alternating currents, and is not likely to do so except in special cases; there seems, therefore, to be no reason for keeping the drop of volts very low on long lines. The sample on the table is a piece of the earth-plate from the Murnau-Oberammergau power station, which has been in use for 20 months; it is estimated that it has passed 7,500 ampere-hours. The corrosion is inappreciable.

The current flowing in the power circuit—*i.e.*; the trolley wire and the return, consisting partly of the rails and partly of the earth—will produce interferences of three kinds on neighbouring telegraph and telephone lines. To simplify the description of these, let us consider a concrete case of a telegraph line on poles running the whole length of the railway. The first effect produced by the power circuit is due to the difference of volts between the earth plates at the two ends of the line, which will produce an alternating current in the telegraph line if, as is usual, it has an earth return. This can be prevented by using an insulated metallic return instead of the earth. Assuming that a wire for this purpose has been erected, the second effect will be that due to the mutual induction between the power and telegraph circuits. This effect is comparatively small, and will not be sufficient to affect the ordinary block instruments on lengths of line corresponding to ordinary block sections; it will, however, be important on longer lines. It can be approximately eliminated by twisting the telegraph circuit. Both of these effects are functions of the current in the power circuit, and are independent of the pressure.

By slightly modifying the ordinary telegraph instrument it is possible to continue to work with the earth return, and thus avoid the expense of the metallic return. Mr. Dahlander, chief engineer of the electric traction department of the Swedish State Railways, has very kindly given me permission to describe two methods which he has successfully used for this purpose. In the first, the iron core of the electro-magnet of the telegraph instrument is surrounded by a copper sheath, consisting of a tube and washers. This damping circuit reduces the magnetism of the iron produced by the alternating current to such a small amount that it does not interfere with the action of the instrument. In the second method, the telegraph instrument is shunted by a condenser; a small liquid condenser of three cells was found to be sufficient on the circuits tested. Full particulars of these experiments will, no doubt, be given when the report of the Swedish experiments is published.

The third effect is due to static induction between the charged trolley wire and the telegraph wire. A charge will be induced in the telegraph wire which is a function of the potential of the trolley wire and is independent of the current in it. As the potential of the trolley wire is alternating the induced potential will also be alternating in sign. The potentials induced in actual cases are surprisingly large. For the Hamburg-Altona line it is calculated that the difference of potential between the telegraph wires and earth would be 1,200 volts, while on the Swedish line the difference of potential is 4,500 volts. If the wire is earthed, the alternating current which will flow in and out of it will be very small—only a few hundredths of an ampere—owing to the small capacity of the line; but this would be sufficient to give a fatal shock. The use of

the metallic return for the telegraph circuit does not eliminate this charge, but roughly doubles it by doubling the capacity of the circuit. The simplest way to avoid this is to earth the circuit at one point, or on long lines, to earth it through a high resistance at several points. These leakage paths will not interfere appreciably with the telegraph currents.

The same three effects are produced on a telephone circuit, but they cannot be dealt with in quite the same way. The induced electromotive force is sufficient to cause a low "hum" in the receiver, which can only be eliminated by putting the wires in a cable. The static charge can be earthed through inductances which allow the low periodicity currents to pass, but not the high periodicity talking currents. All effects are eliminated by using underground cables for both telegraph and telephone circuits.

In calculating the sizes of trolley wire and feeders, &c., the effects of the self-induction of the circuit must be allowed for. If the power factor of the load is good, the self-induction of the line will cause very little drop of voltage at the far end; but if the power factor is low, for instance, on a section of line with only one train on it at the moment when that train is starting, then the induction of the line increases the drop considerably. The drop in voltage at the far end of the line is, of course, quite a different amount from the drop in the return circuit, which may be larger.

It is advisable to adopt a high voltage for the trolley wire; the advantages are many, and the disadvantages mostly imaginary. The higher the voltage the smaller the current, and the less all the effects of induction on neighbouring circuits, and the less the drop in the rails and the better the regulation of voltage. The only undesirable effect which increases with the voltage is the static induction. By far the most satisfactory insulation for all high-tension circuits is porcelain, and with porcelain it is hardly more difficult to insulate for 20,000 volts than for 3,000. The most common objection raised to the higher voltage is the vague one of danger. The danger of falling tramway trolley wires is often spoken of, but it perhaps may not be generally known that there has never been a fatal accident in England due to a broken trolley wire. On careful examination it is difficult to see why 20,000 volts is more dangerous than 3,000; the lower voltage is quite sufficient to kill, and the higher can do no more. Whatever the voltage, it must be recognised that it is fatal to touch the trolley wire, just as it is recognised that it is fatal to stand in front of an approaching train. Nor does the higher voltage materially affect the reliability of the system. In ordinary continuous current systems the power is all generated and distributed at high voltages, usually between 6,000 and 11,000 volts. Of course, these are reduced before reaching the motor, but so they are on the single phase system. It will, however, be wise to proceed gradually in raising the voltage, in case any disadvantage should be found in practice which has not been foreseen. This course is being adopted on the Continent, and 20,000 volts has already been reached; this is quite a low figure compared with ordinary practice in transmission plants. Fortunately, the great flexibility of the single-phase system makes it perfectly easy to alter the voltage, and for the same rolling-stock to run over lines with different voltages. By merely altering the grouping of the coils on the transformers in the carriages, any trolley voltage can be used.

Various forms of bow collector have been used, and for moderate speeds they are all satisfactory, but for high speeds special designs are necessary. The main object of the design must be to reduce the inertia of the moving parts, particularly of the actual contact-bar. The Zossen experiments have shown how this may be accomplished by building the bow up of several parts connected by springs, thus making an extremely flexible construction, having very little inertia at the end, which is the only part which has to make very quick movements, while the lower and heavier parts follow more slowly and provide for the larger motions. The level of the trolley wire has usually to be lower when passing through bridges than in the open, and the bow must have sufficient range of motion to allow for the extreme differences of level. It is also an advantage if the design will allow the bow to reverse itself when the car is run backwards, without forcing the trolley wire to rise. The bow is raised and lowered by air pressure; it is mounted on insulators on the car roof.

It would lead too far to attempt to describe the single-phase motor. It is sufficient to say that the motors which have so far been used for electric traction are mainly of two types—the compensated series motor and the compensated repulsion motor. Both have special advantages, but at present the series motor appears to be rather the better. It was at first supposed that the repulsion motor might be wound for high pressure, and thus save the transformation of the whole power in the car, only that part of the power required for excitation being transformed; it has, however, been found that the starting of the repulsion motor under these conditions is unsatisfactory, and in recent equipments main transformers have been used. These, however, do not do away with the second transformer for the magnetising current, so that two transformers are generally required with this type of motor. Both motors have series characteristics, good power factors, and fairly high efficiencies. The losses in the motors are, however, higher than in continuous-current motors, and forced ventilation is generally used to carry off the heat. Some writers have assumed that the motors must be made much bigger to enable them to get rid of their heat by simple surface radiation and conduction, as is usual with continuous-current motors. The simple expedient of artificial cooling is a more reasonable method of dealing with the problem.

It has been stated by several writers that the effective adhesion of the single-phase locomotive is less than that of the continuous-current locomotive, because of the pulsating nature of the torque given by the single-phase motor. This, however, is not the fact.

The speed of the motors is controlled by connecting them to different numbers of turns on the secondary of the transformer, thus varying the voltage on their terminals. The compensated repulsion motor has also its magnetising current varied in the same way by connecting it to different numbers of turns on the secondary of the small transformer. No resistances are required, and there is, therefore, none of the loss which is inevitable with continuous-current motors. The speed of the motor when running can be regulated to any extent, which can only be done with continuous-current motors to a very limited extent by special devices. The actual switching is done by contactors, as in the continuous-current system. Single-phase magnets are very suitable for operating the contactors; they have the very advantageous property of taking current in proportion to the gap, so that as they close they automatically reduce their current; thus the magnets may be wound to give a large pull at a distance without overheating when kept in circuit. The troublesome vibration has been entirely got over by means of a small short-circuit ring round part of the armature. The great simplicity of the control enables the whole of the switching to be done with seven contactors, including the reversing switches. The rest of the motor-car equipment is very similar to the usual continuous-current apparatus.

It is impossible to deal to-day with the generation of single-phase power. The introduction of single-phase traction is directing attention again to the subject, which has been rather neglected in recent years, owing to the greater popularity of two and three-phase. The size of single-phase generators is rather larger for the same output than that of three-phase generators. Many different methods are being tried for regulating the voltage, and it seems likely that before long a good self-regulating single-phase generator will be available, though at present the regulation leaves a good deal to be desired. This is not a very important matter, so far as the traction is concerned, but it introduces difficulties if the same circuits are used for lighting. This difficulty only arises when the load is very variable, as in small installations, and disappears when the load increases and gets less peaky.

I hope I have said enough to show how varied and numerous the possibilities of electric traction are, and that while many interesting problems are arising in connection with the new system of electrification, they are being successfully solved, and that there is no serious difficulty ahead.

It is very much to be hoped that English railway engineers will not lag behind their foreign *confrères* in introducing electricity on their lines. It is not to our credit that there should not be a single line equipped with single-phase in this country, when lines are already working in Italy, Austria, Germany, France, Belgium, America and Sweden. It is not to be expected that railway companies will embark on extensive schemes at first; it is therefore all the more necessary that they should at once put in hand short lines, so that they may become acquainted with the merits and possibilities of the single-phase system.

BUILDERS, BUILDING OWNERS AND THE LAW OF ELECTRIC LIGHTING.

[BY OUR LEGAL CONTRIBUTOR.]

(*Concluded from page* 276.)

Wires across Private Lands.—It must not be lost sight of that no man can stretch wires across the land of another without permission. In the case of Levy *v.* National Telephone Co. (*Times*, December 18th, 1897), it appeared that the plaintiff occupied a house in London, and that the defendants, who carried on their business under a licence from the Postmaster-General, carried their wires over his house, without touching his house, and without any post or standard being fixed upon the roof. It was stated that about 150 separate wires and three cables containing 100 wires were so carried over the plaintiff's house. The plaintiff brought an action for damages for trespass, and also for an injunction for the removal of the wires. The defendant company, in resisting an application for an interim injunction, urged that some of the wires had been over the house for 13 years, and that the plaintiff had only been in occupation of it for a short time; and that there was no danger to the plaintiff's house in allowing the wires to remain until the trial. An injunction was granted by Mr. Justice Day, whose decision was affirmed by the Court of Appeal. If this is the law as regards telephones, it may be taken that the suspension of any wires bearing a powerful current of electricity above a house may be restrained by an injunction.

Attachment of Wires, &c., to Buildings.—The Electric Lighting Acts do not specifically refer to the placing of lines in such a position as to interfere with buildings. It is, however, provided by Sec. 7 of the Gas Works Clauses Act, 1847, which is incorporated with the Electric Lighting

Act, 1882, that nothing in the Act of 1847 shall authorise or empower the undertakers to lay down or place any line or other works into, through, or against any building, or in any land not dedicated to public use, without the consent of the owners or occupiers thereof; except that the undertakers may at any time enter upon, and lay, or place, any new line in the place of any existing pipe, in any land wherein a line has already been lawfully laid down or placed in pursuance of an Act of Parliament, and may repair or alter any line so laid down. It has been held that certain arches used as cellars under the street adjoining the plaintiff's premises were buildings within the meaning of the above section. (Thompson *v.* Sunderland Gas Co. (1877) 2 Ex., D. 429.)

An estate having been laid out for building, a part was also laid out as private roads, and upon a petition the owners taking the private roads covenanted that the other freeholders and occupiers of the houses should have the full use and enjoyment of the roads in as absolute a manner as if they were public roads. A request by a minority of the occupiers of houses to be supplied with gas was held to be sufficient without the consent of the freeholders to justify a gas company (whose special Act incorporated the Gasworks Clauses Act, 1847) to lay down pipes along the said roads (Selby *v.* Crystal Palace District Gas Co. (1862) 31 L.J., Ch. 595).

A telephone company having placed wires on the roofs of houses and passed them diagonally across a street, the local authority took proceedings to obtain an injunction. It was found at the trial that there was no danger and no nuisance. The streets were vested in the local authority under Sec. 96 of the Metropolis Management Act, 1855. An application by the local authority for an injunction to restrain the telephone company from allowing their wires to remain in this position was refused. (Wandsworth Board of Works *v.* United Telephone Co. (1884), 13 Q.B.D. 904).

Nuisances Caused by Electrical Undertakers.—In view of the fact that electrical machinery is often noisy, and that undertakers cannot carry out their obligations unless they have a generating station, it may become necessary to consider how far they can be held liable for nuisance.

It is provided by the Electric Lighting (Clauses) Act, 1899,* that "nothing in this order shall exonerate the undertakers from any indictment, action or other proceedings for nuisance in the event of any nuisance being caused by them." This provision has been strictly construed adversely to the supply companies and authorities. In Shelfer *v.* City of London Electric Lighting Co. ((1895), 1 Ch., 287), an electric lighting company erected powerful engines and other works on land near a house which was subject to a lease. Owing to excavations for the foundations of the engines, and to vibration and noise from the working of them, structural injury was caused to the house, and annoyance and discomfort to the lessee. The lessee and the reversioners brought separate actions against the company for an injunction and damages in respect to the nuisance and injury this occasioned. Kekewich, J., after finding on the evidence that the defendants had created a continuing nuisance as regards the lessee and had caused structural injury to the house, held that both the lessee and the reversioners were entitled to relief, but under the circumstances by way of damages and not by injunction. The plaintiffs in both actions appealed against the refusal of the injunction; and the Court of Appeal held that there was nothing in either case to justify the Court in refusing to aid, by injunction, the legal rights which had been established, and that the appeal must be allowed.

Tramway Outing.—On the invitation of the Hon. Arthur Stanley, M.P., Chairman of the Lancashire United Tramways, Ltd., the employés of the South Lancashire Tramways Co. and the New St. Helens and District Tramways Co. and their wives have had a most enjoyable entertainment at Knowsley Park, kindly lent by the Earl of Derby. Others invited included Mr. C. W. Mallins (manager of the Liverpool Tramways), and Mr. J. R. Salter (manager and engineer of the Lancashire United Tramways). Prizes for sports were presented by the Hon. A. Stanley.

* *Schedule*, Sec. 79. This Schedule, as already pointed out, is incorporated with every provisional order.

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

19,616a/05. "Improvements in electric batteries." G. Schauli. (Date applied for under Rule 5 of the Patents Rules, 1905, September 28th, 1905.) August 8th.

17,703. "Improvements in single-phase alternating-current electric motors." F. W. Davies. August 7th.

17,726. "Devices for clamping stereotype and other printing plates." W. C. Fairweather. (F. B. Redington, United States.) August 7th. (Complete.)

17,742. "Improvements in solenoid controlled electric switches." A. H. Curtis and A. H. Adams. August 7th.

17,768. "Improvements in the mode of and means for electrically treating air and other gases." J. H. Bridge. August 7th. (Complete.)

17,785. "Improvements in means for regulating the potential difference at the terminals of dynamo-electric generators driven at varying speeds." E. J. Javaux. (Date applied for under Patents Act, 1901, August 9th, 1905, being date of application in France.) August 7th. (Complete.)

17,786. "Improvements in connection with electricity supply systems." G. Wilkinson. August 8th.

17,800. "Improvements in electric cut-out and distribution boxes." G. Scoccimarro. August 8th.

17,812. "Improvements in appliances for use in connection with the electric ignition systems for internal combustion engines." Electric Ignition Co., Ltd., and F. H. Hall. August 8th.

17,827. "Improvements in electrical signalling apparatus serving both as transmitter and receiver operated by alternating currents." Siemens Bros. and Co., Ltd. (Siemens & Halske Akt.-Ges., Germany.) August 8th. (Complete.)

17,886. "Improvements in and relating to apparatus for adjusting the height of electric lamps." C. B. Fabrik für Elekt. Installationsmaterial Ges. August 9th. (Complete.)

17,911. "Improvements in controlling single-phase commutator electric motors." Siemens Bros.' Dynamo Works, Ltd. (Siemens Schuckertwerke Ges., Germany.) August 9th. (Complete.)

17,930. "Improvements relating to electric switches." L. Auerbach. August 9th. (Complete.)

17,944. "Wireless telegraphy." L. H. Walter. August 10th.

17,946. "Improved rotatory bar electrical ignition for internal combustion engines." G. Anderson & Co., Ltd., and J. A. Ross. August 10th.

17,976. "Improvements in and relating to igniters with filament." F. Deimel. August 10th. (Complete.)

17,981. "Apparatus for the electrolytic production and separate collection of gases." J. Wetter. (Elektrizitäts Aktien Gesellschaft, vormals Schuckert and Co., Bavaria.) August 10th.

17,987. "Improvements in or relating to electric accumulators." C. Bosel and L. Denereaz. (Date applied for under Patents Act, 1901, August 11th, 1905, being date of application in Switzerland.) August 10th. (Complete.)

18,010. "Improvements in letters for electric signs." H. B. Camp. August 10th. (Complete.)

18,013. "Improvements in electricity-measuring instruments." J. Y. Johnson. (Hartmann & Braun Aktien-Gesellschaft, Germany.) August 10th. (Complete.)

18,054. "Improved backing for half-tone blocks, electrotypes and the like." W. Brown and A. Weber. August 11th. (Complete.)

18,060. "Improvements in and relating to devices for cooling electrical machines or apparatus." Allgemeine Elektricitats Gesellschaft. (Date applied for under Patents Act, 1901, August 12th, 1905, being date of application in Germany.) August 11th. (Complete.)

18,079. "Improvements in the electro-deposition of metals or alloys upon metallic and other surfaces." J. H. S. Bradley and M. Salis-Schwabe. August 11th.

18,080. "Improvements in the method of precipitating metals electrolytically." A. Ramen. August 11th. (Complete.)

18,083. "Commutator switch for two igniting sources of electricity." A. Horch. August 11th. (Complete.)

18,086. "Improvements in and relating to fuse boxes." H. J. Herberts and C. A. Herberts. August 11th. (Complete.)

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1905.

Appliance for Protecting Electric Apparatus against Currents of Excessive Strength or Voltage. Soc. Industrielle des Telephones Constructions Electriques Caoutchouc Cables. 25,153. December 4th. (Date applied for under International Convention, December 13th, 1904.)

Electro-Mechanical Block Signalling Systems for Railways and the like. A. Beer. 8,655. April 22nd.

Electric Furnaces. T. Parker. 14,884. July 19th.

Process of Obtaining Thorium Applicable for Making Incandescent Electric Lamp Filaments. British Thomson-Houston Co., Ltd. (General Electric Co.) 14,972. July 20th.

Electric Train Control Systems. A. Sundh and A. Magnuson. 15,045. July 21st. (Date applied for under International Convention, February 16th, 1905.)

Manufacture of Electrical Resistances. C. Ruzicka. 15,320. July 26th.

Employment of Telephone Meters in Common Microphone Battery System. H. Oppenheimer. (Akt.-Ges. Mix & Genest.) 15,435. July 27th.

Electro-Capillary Recording Apparatus. A. Orling and F. W. Corby. 16,143. August 8th.

Magnets and Solenoids for Electrical Measuring Apparatus. J. Herman. 17,093. August 23rd.

Manufacture of Iron or Steel in an Electric Furnace. P. Gredt. 17,178. August 24th.

Signalling Arrangements for Electric Tramway Systems, Railways and the like. N. Norris. 17,768. September 2nd.

Arc Lamp Electrodes and Methods of Making the Same. British Thomson-Houston Co., Ltd. (General Electric Co.) 18,484. September 13th.

Universal Ball Joint or Socket Suitable for Supporting Electric Light Fittings and for other Purposes. H. Hirst and J. H. Collings. 18,646 September 15th.

Sparking Plugs for Internal Combustion Engines. R. H. N. Lindley and J. B. King. 19,129. September 21st.

Systems of Electrical Distribution Employing Rectifiers. British Thomson-Houston Co., Ltd. (General Electric Co.) 22,261. October 31st.

Method of and Apparatus for Striking Electric Arcs between Electrodes. A. J. Petersson. 25,287. December 5th.

Systems of Electrical Distribution. British Thomson-Houston Co., Ltd. (General Electric Co.) 25,405. December 6th.